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# OBSERVATIONS ON THE TESTING AND USE OF PORTLAND AND NATURAL CEMENTS.

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[*Read December 12, 1906.*]

The present remarkable development in the use of cement is the direct outcome of the careful and persistent observations and experiments of our engineers, mechanical, chemical, and civil. There is not a structure of modern times built of natural stone or forms of burnt clay that has not been duplicated in cement. Cement is now meeting structural requirements hitherto impossible except by the use of iron, steel, and timber, and its advantages over the latter materials in the matters of cost, durability, and freedom from injury by fire and water are only just coming to be known. Time has shown that when cement is carefully selected and treated intelligently in the practical work of construction, enduring monuments are founded, to the honor and credit, not alone of the designer and builder, but, in justice be it said, to the pioneers and courageous supporters of this important industry in our country, who have persevered in face of many discouraging and adverse conditions until the American product is recognized as standard the world over.

While the rapid growth of the Portland cement industry since 1895, and the extended use of the material in all forms of construction, may be well taken as a tribute to its improvement and reliability, the better understanding and appreciation, not only of the users, but of engineers and architects as well, must also be

considered of the utmost importance. Hydraulic cements have been made and used for more than a century; and yet it has remained for investigators of comparatively recent years to throw much light upon the subject, and the light must be disseminated widely before the full benefit will be derived.

The adoption of a standard specification for Portland and natural cements during 1904 by the joint committee of the American Society of Civil Engineers and of the American Society for Testing Materials has proved a happy issue out of the maze of conflicting requirements which the manufacturer has met throughout the country in years past. It was perfectly natural, under such conditions, that doubt and suspicion of a product so little known should prevail among the uninformed. Before the adoption of the standard specifications, and even to-day to some extent, much conflict of opinion was found upon some of the most vital principles governing the acceptance of cement; each tester or engineer performing this duty was a law unto himself and exercised the full prerogatives of his official position in fixing requirements and interpreting results, oftentimes prescribing tests that were misleading and fallacious as an indication of quality, and which only served to vex and hamper the manufacturer; and in such cases an effectual barrier was set up between the very interests that have since combined and coöperated to the great benefit of all concerned.

In the absence of better information it may be natural for the user of cement to entertain with suspicion the statements of the manufacturer relating to the quality of a cement in question, but it seems obvious that with standard specifications and uniform methods of testing, combined with full and up-to-date information upon the results of the several determinations made, there would follow greater uniformity in the material, less opportunity for dispute, and a greater degree of confidence and mutual respect between men who are seeking the same attainments — excellence of material, design, and workmanship in all projects that mark the prosperity and progress of our country.

With an experience covering nearly eighteen years upon important hydraulic construction, I have found opportunity to observe many variable conditions affecting the requirements and

use of cement, and I know of no material entering into construction of which so much is expected that is subjected to the same or equal abuses; yet when a failure is recorded — happily very rare — how common it is to see the fault ascribed to the cement! The experienced and responsible manufacturer of cement believes in and encourages the intelligent testing of his product, and naturally of competing brands as well, and the time is not distant when he will *insist* upon tests being made in advance of use in reënforced concrete construction, or in other cases where he may be informed of either ignorant, careless, or dishonest methods, dangerous proportions, or the use of unsuitable materials to be combined with the cement.

An idea will obtain in the classroom, office, or laboratory which, if carried out or closely approximated in construction, would give excellent results; but how often this idea is forgotten or overlooked in construction, and crude — yes, cruel — methods of work are suffered! This can, under some conditions, be said even of cement-testing. Young men without previous experience or any knowledge whatever of the subject are sometimes selected for this work; and although they may have a high degree of intelligence, and be industrious and conscientious in their work, yet the best that can be said of such a selection is that it is more likely to result in causing a good cement to be questioned than in passing a poor one, although the latter chance is not remote; meanwhile, little consideration is shown the manufacturer or the reputation of his product.

Once asked to explain the difference in results obtained by two testers working together, using the same amount of water in mixing and following the same methods of molding, etc., I offered the somewhat parallel case of two cooks making bread from the same flour, same yeast, and same formula throughout, and yet the quality and appearance of the loaves would be quite unlike.

The personal equation cannot, perhaps, be removed in testing cement, but other conditions that vitally affect the results can be brought to a more uniform basis, and these in ordinary practice may briefly be summed up as the quantity of water used to produce a paste or mortar of given consistency, time and manner of manipulation, method of molding, temperature of water and air,

time and conditions of exposure in air and water, and rate of applying the load.

When tests are made under the instructions of the standard specifications by an experienced and skilled operator, they form a record valuable not alone to the work in which the material is being used, but to all users of cement who may have access to the results. Uniform tests, under a standard specification, serve to show:

*First.* Whether the material meets the standard or fixed requirements.

*Second.* Uniformity of the product tested.

*Third.* A comparison with other brands of the same material, which is invaluable at times when making a selection and computing the real relative net values.

Without a uniform specification and uniform tests thereunder, it is obvious that results could give no indication of uniformity of product, and a comparison with other brands or with the same brand tested at other points would be meaningless to a great extent. Training and experience are regarded as essential in any technical, mechanical, or professional work to produce results that are scientific, accurate, and dependable; the operator must know the full significance of his determinations or he will at times omit some detail or overlook a precautionary measure that may have a marked effect upon his results. Only trained, experienced men should be intrusted with the testing of cement on important public or private work where results are carefully tabulated and published in reports or otherwise circulated, and it is of great benefit and interest to all users of cement that we may have such results to refer to. The small or casual user of cement hardly finds it expedient or necessary to attempt a chemical analysis or test for specific gravity; in fact, when he is using a well-known and established brand he need feel little concern about this, and the tests for soundness, sand-carrying capacity (which he determines by tensile tests of sand mortars), time of setting, and fineness, all together have a bearing on the chemical proportions and specific gravity that means much to the experienced observer.

Tensile tests of *neat* cement are useless in determining the real relative strength of several brands of cement, and tests of

mortar of the proportion of 1 cement to 3 sand, by weight, should alone be considered in making comparisons. We *use* the cement with sand, not neat, and we want to know what to expect in our work. Many cements, both Portland and natural, give very satisfactory results in the neat test, but show marked inferiority compared with the best brands of both grades when tested for their sand-carrying capacity. Unless the standard Ottawa sand or crushed quartz be used throughout the test, we must recognize the fact that variable results will follow. which are not due to the cement, but to the sand.

The effect of water in retarding the induration of cements and reducing their tensile strength, particularly at short periods, has long been known, and more or less information has been published as the result of experiments made.

The writer was led to make a series of tests on these lines during 1901, in somewhat more detail than anything he had seen published, and it is the result of this experiment, shown in the diagrams (Figs. 1 and 2) and in Table No. 1, that we will now consider. It may be stated that one man made the briquettes for the entire series, six for each period, at each interval in the amount of water used; the water used in mixing was at a uniform temperature of 63° F., and the temperature of the air averaged slightly under 70° F. and fluctuated between 50° and 75° F. Two briquettes of Am. Soc. C. E. standard form were gaged at a time, and beginning with the dry mixtures the molds were filled in three layers, each rammed successively until flushed, with a trowel. The ramming process continued until the mixtures became too soft, when the molds were filled by pressing in with the thumb and troweling. So far as possible the briquettes were allowed to set in air, under a damp cloth, for about two hours after taking the heavy wire, before immersion; this practice could not be followed uniformly, and some of the softer mixtures were allowed to set in air over night, and in a few instances the operator was obliged to wait until late in the night to complete his observations. In determining the rate of setting, the Gilmore needles were used. Care was observed to use the same sample of cement throughout the series, and this was taken from the storehouse of contractors engaged in the construction of large public work. The decimal

## TABLE No. 1.

SHOWING TENSILE STRENGTH OF CEMENTS MIXED NEAT WITH DIFFERENT PROPORTIONS OF WATER.

| Cement brand. | Water. Per cent. | Sieve Test; residue on | | | Wire; minutes: | | Tensile Strength; pounds per sq. inch. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. 50. | No. 100. | No. 180. | Light. | Heavy. | 24 Hours. | 7 Days. | 28 Days. | 3 Months. | 6 Months. | 12 Months. |
| "Giant" Portland. | 13 | | | | | | | | | | | |
| | 14 | | | | | | | | | | | |
| | 15 | 0.15 | 5.4 | 21.2 | 12 | 207 | 371 | 655 | 875 | 941 | 720 | 787 |
| | 16 | .. | .. | .. | 29 | 297 | 303 | 750 | 973 | 1 008 | 735 | 816 |
| | 18 | .. | .. | .. | 80 | 355 | 260 | 649 | 773 | 831 | 645 | 748 |
| | 20 | .. | .. | .. | 142 | 402 | 233 | 500 | 693 | 716 | 621 | 676 |
| | 22 | .. | .. | .. | 268 | 473 | 184 | 546 | 635 | 658 | 601 | 589 |
| | 24 | .. | .. | .. | 327 | 912 | 167 | 539 | 649 | 644 | 629 | 755 |
| "Union" Natural. | 23 | 0.1 | 4.6 | 10.2 | 13 | 32 | 212 | 251 | 252 | 311 | 275 | 356 |
| | 24 | | | | | | | | | | | |
| | 25 | .. | .. | .. | 18 | 39 | 185 | 218 | 215 | 289 | 300 | 341 |
| | 27 | .. | .. | .. | 21 | 42 | 150 | 188 | 220 | 257 | 272 | 314 |
| | 29 | .. | .. | .. | 20 | 52 | 128 | 178 | 202 | 246 | 248 | 256 |
| | 31 | .. | .. | .. | 21 | 57 | 112 | 173 | 199 | 224 | 259 | 309 |
| | 33 | .. | .. | .. | 27 | 85 | 104 | 172 | 182 | 267 | 246 | 290 |
| | 35 | .. | .. | .. | 38 | 137 | 93 | 121 | 178 | 260 | 286 | 319 |
| | 37 | .. | .. | .. | 34 | 160 | 85 | 108 | 168 | 262 | 306 | 326 |
| | 39 | .. | .. | .. | 67 | 233 | 85 | 119 | 202 | 252 | 371 | 400 |
| "Atlas" Portland. | 13 | 0.1 | 7.0 | 18.0 | 13 | 270 | 366 | 775 | 859 | 1 067 | 892 | 832 |
| | 14 | .. | .. | .. | 18 | 303 | 404 | 780 | 891 | 972 | 852 | 781 |
| | 15 | | | | | | | | | | | |
| | 16 | .. | .. | .. | 22 | 327 | 363 | 602 | 725 | 844 | 806 | 723 |
| | 18 | .. | .. | .. | 15 | 383 | 308 | 570 | 723 | 785 | 728 | 724 |
| | 20 | .. | .. | .. | 56 | 703 | 225 | 590 | 718 | 760 | 674 | 636 |
| | 22 | .. | .. | .. | 52 | 833 | 166 | 554 | 649 | 731 | 643 | 604 |
| | 24 | .. | .. | .. | 188 | 918 | 42 | 510 | 691 | 695 | 632 | 574 |
| "Hoffman" Rosendale. | 23 | 2.3 | 12.4 | 21.9 | 22 | 59 | 138 | 177 | 271 | 332 | 284 | 264 |
| | 24 | .. | .. | .. | .. | 78 | 125 | 141 | 264 | 342 | 309 | 310 |
| | 25 | .. | .. | .. | 35 | 120 | 150 | 164 | 216 | 308 | 318 | 321 |
| | 27 | .. | .. | .. | 49 | 143 | 117 | 116 | 194 | 305 | 345 | 272 |
| | 29 | .. | .. | .. | 76 | 166 | 96 | 105 | 164 | 272 | 320 | 267 |
| | 31 | .. | .. | .. | 117 | 212 | 72 | 72 | 159 | 270 | 371 | 225 |
| | 33 | .. | .. | .. | 115 | 235 | 62 | 71 | 147 | 277 | 379 | 244 |
| | 35 | .. | .. | .. | 127 | 400 | 50 | 64 | 112 | 245 | 318 | 315 |
| | 37 | .. | .. | .. | 198 | 828 | 59 | 62 | 96 | ... | 284 | 351 |
| | 39 | .. | .. | .. | 260 | 1 057 | 54 | 56 | 85 | ... | 355 | 364 |

MEMORANDA. — Results shown are the averages of six briquettes made.

scale of weights was used in gaging, the graduate glasses being carefully calibrated to agree, and the briquettes were broken on a Fairbanks machine of late pattern, the clips having roller bearings of composition metal.

Chemical analyses of the cements here considered were not made for this test, but the characteristics of the brands named are doubtless well known to many, and will be only briefly referred to. The Atlas and Giant brands of Portland cement both come from the Lehigh district of Pennsylvania, and, in their chemical composition, are in quite close agreement. The "Union" natural is also made from the Pennsylvania cement rock of the Lehigh district, is light in color, and its composition is quite unlike the "Hoffman," which is dark in color, being made from the magnesian limestone of the Rosendale district, New York. "Union" more closely approaches the Portland standard in composition, and differs from the "Hoffman" noticeably in its lime and magnesia content, having about 50 per cent. lime and 2 per cent. magnesia, while the "Hoffman" has about 36 per cent. lime and from 16 to 18 per cent. magnesia, which is characteristic of nearly all the New York Rosendale cements. The low magnesium content, together with the very fine grinding of "Union," cause it to be more active and quicker setting than "Hoffman," and this is well shown in the table and diagram, particularly in the wetter mixtures.

As might be expected, this difference in the cements would be in greater contrast when combined with sand in concrete mixtures than in neat cements; and, in fact, it was the dissimilar results in practical work of construction that led to this experiment. I regret that the experiment did not also include mortar mixtures in the proportion of 2 sand to 1 cement for the natural cement, and 3 sand to 1 cement for the Portland, wherein conditions more closely approximating the operations of every-day practice would obtain.

From personal acquaintance with a recent large work of concrete construction the writer is forced to the conclusion that when any reliance must be placed upon the cohesive strength of Rosendale cement within six months, or perhaps longer, depending upon the exposure and local conditions, great care must be exer-

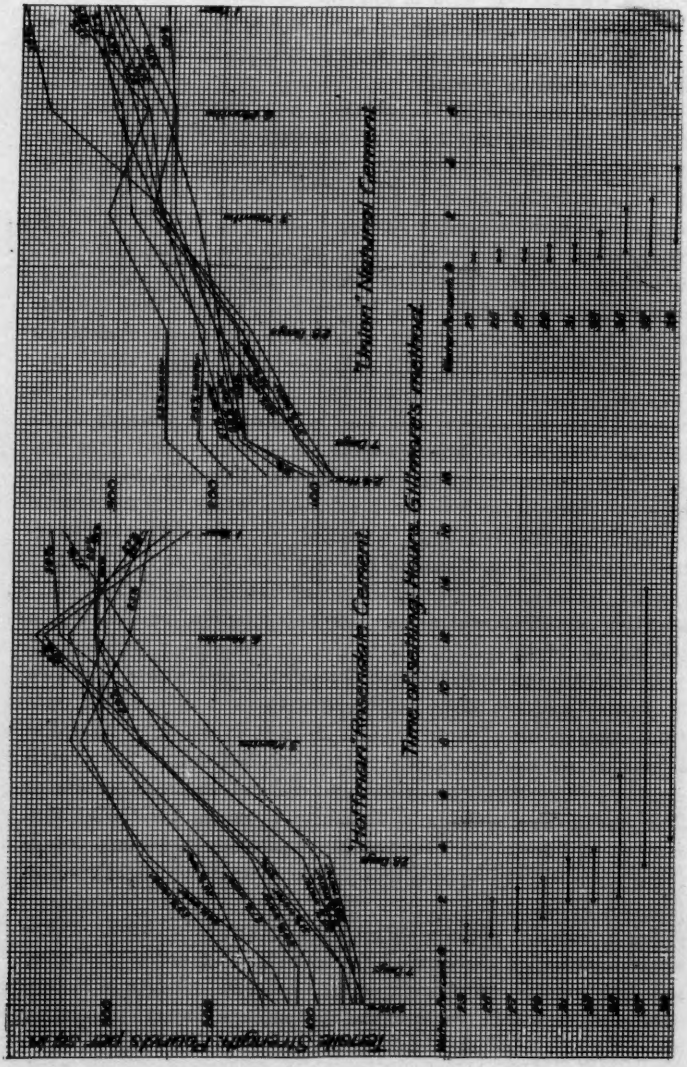
Portland Pozzolan Cement
Times of setting Mixture Gillmore's method
Dexter's Natural Cement

Fig. 1.

cised in proportioning the amount of water used; or, in the present day of wet concretes, in selecting a cement that successfully withstands the deteriorating influence of an excessive amount of water.

In the diagram of tensile results (Fig. 1), the dryer mixtures of the "Hoffman" cement show superiority up to the 28-day period, at which time it is quite marked and uniform; the gain in strength between the 24-hour and 7-day periods appears slow, and grows slower as the amount of water is increased; the improvement between the 7-day and 28-day periods is better, but the rate of gain appears generally in favor of the dryer mixtures; the gain in all mixtures between this and the 3-month period appears quite uniform, and develops a rapid gain for the wetter mixtures; after the latter period inconsistencies develop, and between six months and one year only the 37 per cent. and 39 per cent. series show any appreciable gain, and the wettest mixture appears superior at the end of the year, the others generally showing a falling off in strength, for which I can offer no explanation.

In the "Union" cement series the dry mixtures generally appear superior at the 24-hour and 7-day periods, the rate of gain is quicker and quite uniform; as in the Portland cements, the gain in strength of the wetter mixtures is more rapid between seven days and twenty-eight days, the wettest mixture having passed four of the series next below, and all of the series being closer together than at the two earlier periods; at three months only the 23 per cent. and 25 per cent. series held their superiority, the wetter mixtures rapidly overtaking all others and being in close agreement, with the exception of the 31 per cent. series, which made a slower gain; after this period peculiarities develop for which no explanation can be offered, but the uniform rate of improvement is noticeable in all instances, and the results at one year are better in each case than at any preceding period, the 23 per cent. and 33 per cent. series showing a falling off between three months and six months with a good recovery at one year.

In the Portland cement series (Fig. 2) the rapid and uniform improvement between twenty-four hours and seven days is noticeable, but the dryer mixtures generally hold their superiority; this is noticeably uniform in the "Atlas" cement at all periods; the maximum strength was attained at three months,

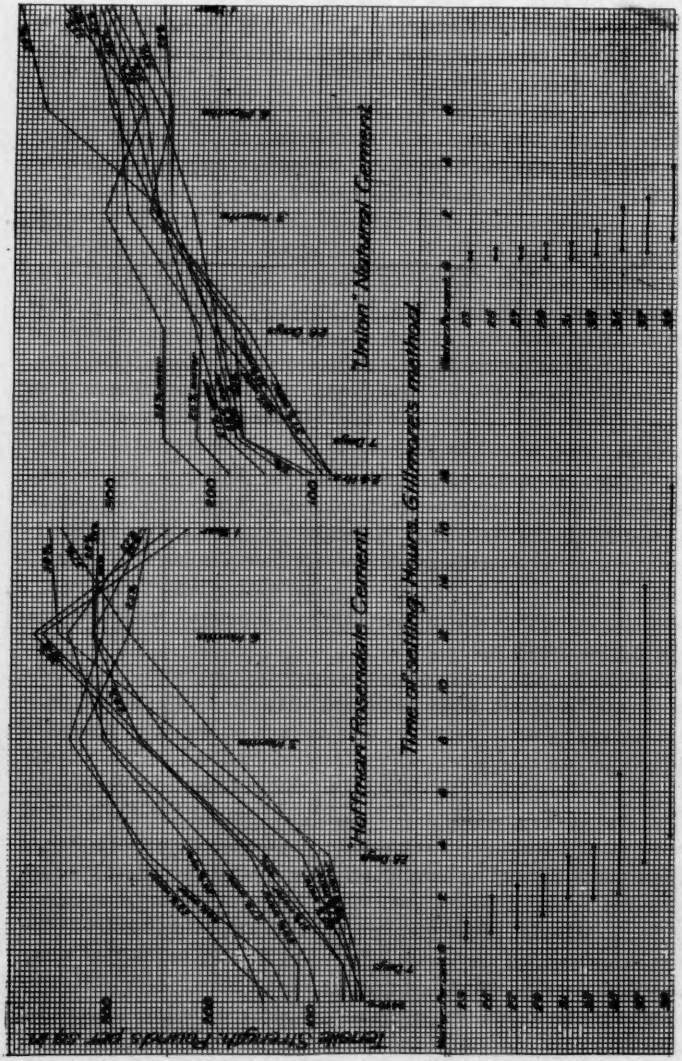
Tensile Strength Pounds per sq. in.
Time of setting Hours. Gillmore's method
Hoffman Rosendale Cement
Union Natural Cement

Fig. 1.

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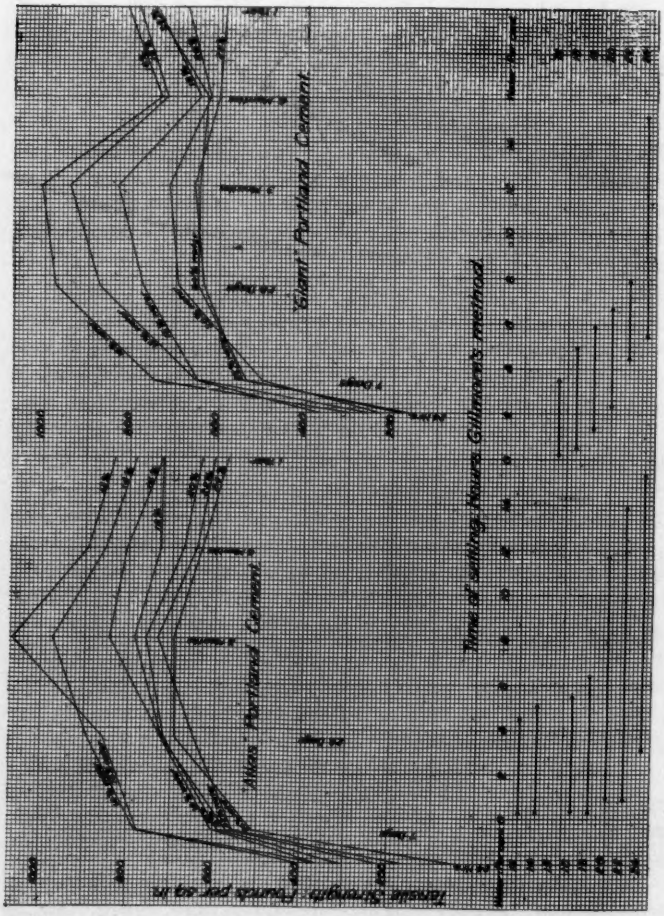
Giant Portland Cement.
Time of setting Portland Cements, Gillmore's method.
Mean Portland Cement.
Tensile Strength Pounds per sq in

FIG. 2.

after which, and up to one year, there appears a steady falling off in strength; but from three months on the dryer mixtures are uniformly better.

The " Giant " cement also attained its maximum strength at three months, at which period the dryer mixtures also appear uniformly superior, with the exceptions of the 15 per cent. series; and judging from the results of this series throughout the test, it would appear that in this case there was not quite enough water used to perfect the crystallization of the cement. The " Giant " cement also shows a falling off between three months and six months, but a good recovery after this latter period in all but one series, 22 per cent.; and the wettest mixture, 24 per cent., passed the three series next below at one year, — two of them in fact in six months, — and between six months and one year it showed a more rapid gain than any of the other series.

The personal equation is apparent in these tests, as in any tests of the tensile strength of cements, but every effort was made to secure consistent and uniform results, and I will repeat that one man made the test throughout the entire series for the four cements named.

Cement or concrete construction, with or without steel reënforcement, is coming rapidly into favor, supplanting steel, stone, brick, and lumber in all forms of construction, and it is but natural that mistakes and failures sometimes attend the efforts of the inexperienced; and certain retribution is in store for the dishonest workers; but it is a remarkable tribute to this comparatively new system of construction that so few failures have been recorded during the phenomenal growth of the industry.

We find recorded failures in all styles of construction, brick, stone, steel frame, and timber, as well as concrete, but because of trade jealousies and the hostility of some labor unions, the failures in concrete construction are the best advertised at the present time. It is significant, however, that practically every instance of failure in concrete has occurred during construction, and has been chargeable to carelessness or incompetence. Unlike iron and lumber, concrete is not destroyed by fire, nor does it rust out or decay, but in fact becomes stronger and more durable with time, and the scores of splendid examples of this plastic con-

struction throughout the country are telling proofs of its merit and adaptability.

Low first cost is not necessarily ultimate economy, and if concrete did not perform its duty well and stand the test of time, other materials would surely supersede it. It is of the greatest commercial importance to all in the industry that quality should be a first consideration. You well know how the slightest imperfection in concrete work is pointed out by hostile interests as a sign of inferiority or failure, and a small crack which would be overlooked in brick work is viewed by the uninformed as a forerunner of sure and sudden collapse. Use only high-grade cement and select your sand with care, and beware of sand containing loam or clay; clean siliceous sand, ranging from fine to coarse, gives the best results; test it in combination with your cement before using. The ballast or coarse aggregate should also be clean, and of varying size in order to reduce the voids to a minimum. Gravel and igneous rocks furnish the best stone for concrete, much better than limestone for fireproof construction. For crushed stone, use a ¼-inch mesh dust jacket on the sizing screen; you will then have a more uniform product. The amount of dust varies with the size, shape, and character of the stone crushed, and also upon the rate of feed into the crusher, the speed of the crusher, and the degree of moisture in the stone. Stone dust, if clean, is better than most sands, but should be accurately gaged as sand, and more care is required to thoroughly incorporate it with cement because of the large percentage of fine material contained.

If crushed stone is stored or binned, as in most work requiring reserve stock, a more uniform mixture can be drawn from the bins when using, if the dust be excluded, since the latter serves to pack or cement the stone together, and alternating loads of coarse and fine will surely result in loading from heaps or drawing from bins.

In securing quality, thoroughness and care of mixing and placing concrete are of the utmost importance; *carelessness in placing will undo the work of mixing.*

Proportions of cement, sand, and stone will vary, depending upon the work to be done, but it is well to keep in mind:

*First.* That the stone voids should be a little more than filled with sand, and the sand voids a little more than filled with cement if strength is desired.

*Second.* That the voids in ordinary sand vary from 30 to 42 per cent., so that if leaner proportions than 1 cement to 3 sand be used, the cement will not fill the voids and the mortar will be porous.

*Third.* Accurate gaging is essential to uniform results.

A word as to consistency or amount of water used:

Wet concrete is the order of the day, and while I believe in using too much rather than too little water, still, in my judgment, much concrete is made too wet, and if in this condition much tamping, spading, or forking be done, the coarse aggregate will be driven to the bottom of each layer placed and a very unequal distribution of cement throughout the mass will follow. Except in the presence of very intricate reënforcement the mortar should be of a consistency to easily support the coarse aggregate and admit of light tamping. *Excess water serves to undo the work of thorough mixing.*

With a view of determining the variability of wet mixtures, the writer made the following test this past year:

Gang molds were placed vertically over each other, eight in all, to contain a layer 8 inches deep; the joints between molds were sealed with a thin layer of a mixture of white wax and tallow to prevent the escape of water. A high-grade Pennsylvania Portland cement was used in the proportion of 1 part cement to 3 parts of standard Ottawa sand, by weight, gaged with 20 per cent. water. Fine annealed wire (32 gage) was inserted between consecutive molds, and when the mixture had partially set these wires were used to cut the gang molds apart, and the operation was satisfactory in producing perfectly formed briquettes. The briquettes were then allowed to remain in the molds over night, under a damp cloth, and were then removed and immersed in water until broken.

The consistency of this mortar compared closely with that of much of the wet concrete now used, — dryer than some I have seen used in large work. When the molds were filled the mixture was churned and worked with a glass rod about ¼-inch in diam-

eter. The following results (Fig. 3) are the average of three briquettes, a total of 48 being in the series; No. 1 briquette is from the top layer and No. 8 from the bottom.

The purpose of this experiment would have been accomplished in the test for one period alone, but it was deemed inexpedient to make the trial for any time short of one month. The inferiority of the briquettes in the bottom layers is clearly apparent, there being a maximum loss in strength of 117 pounds at twenty-eight days and 151 pounds at forty-five days. It would appear entirely reasonable to assume that a greater variation will be found in a 7-day test than in either of the above two noted.

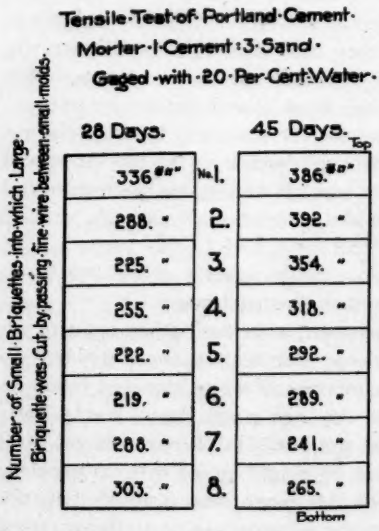


FIG. 3.

Concrete, to be of the utmost value, should be a true monolith of uniform strength throughout; this is of vital importance in beam, girder, and slab construction, and is not difficult of attainment.

This would seem to suggest that the idea of proper consistency is worthy of serious consideration, and further experiment, in the line of compression tests also, may bring forth interesting facts.

Table No. 2 and the diagram, Fig. 4, are also given showing the tensile strength of Portland cement mortar mixed in the proportion of 1 cement to 2 sand and gaged with different percentages of water, ranging from 8 per cent. to 20 per cent. Sand known locally as " Plum Island " sand was used. This is a dredged sand, very clean, selling at $1.60 per ton delivered. High-grade Pennsylvania cement was used. The results given are the aver-

age of three briquettes. Percentage of water used was determined on the combined weight of cement and sand. Briquettes were immersed in water until broken after remaining twenty-four hours in a moist air closet. The injurious effect of using too little water is plainly evident in the 8 per cent. series, and requires no further emphasis. Up to six months the superiority of the dryer mixtures, excluding the 8 per cent. series, is quite uniform,

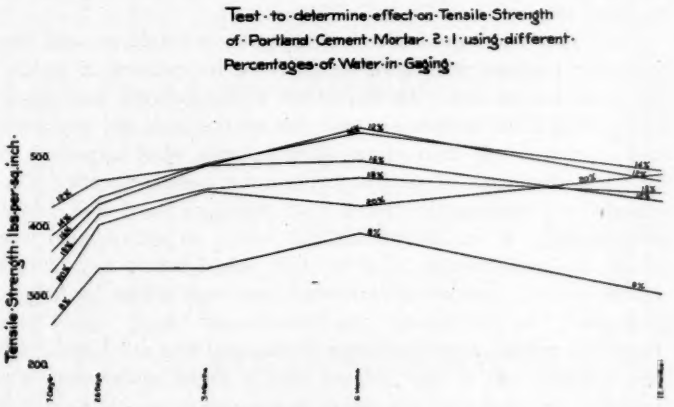
Test to determine effect on Tensile Strength of Portland Cement Mortar 2:1 using different Percentages of Water in Gaging
Tensile Strength lbs per sq inch
500
400
300
200

FIG. 4.

and it would appear that from 12 to 15 per cent. water would give the best results in a mortar of this composition, namely, 1 cement to 2 sand. Fourteen per cent. water will yield a very plastic mortar if properly tempered.

TABLE No. 2.

PORTLAND CEMENT MORTAR, 1 CEMENT TO 2 SAND.

| | TENSILE STRENGTH, POUNDS PER SQUARE INCH. | | | | | |
|---|---|---|---|---|---|---|
| Water — per cent. / Time of Test. | 8 | 12 | 14 | 16 | 18 | 20 |
| 7 days ..... | 261 | 433 | 392 | 368 | 338 | 301 |
| 28 „ ..... | 344 | 470 | 447 | 436 | 422 | 407 |
| 3 months ..... | 344 | 490 | 494 | 491 | 457 | 454 |
| 6 „ ..... | 392 | 543 | 536 | 497 | 472 | 430 |
| 12 „ ..... | 300 | 463 | 478 | 434 | 446 | 474 |

It is gratifying to note the growing appreciation of the important part sand plays in all cement work, for in very many instances poor results are directly chargeable to the sand used. No cement will improve properly if mixed with very fine sand, and results will vary depending upon the characteristics of the fine material. It must also be kept in mind that an intimate mixture of cement and fine sand is very difficult to attain, and a thorough distribution of cement throughout the sand voids is absolutely essential to good results.

Sand that looks good is not always above suspicion, and the following instance will serve to show the importance of testing the sand before use. An important hydraulic work was begun last year in New Brunswick, and the contractors and engineers had congratulated themselves upon having what appeared to be an ideal deposit of sand and gravel for concrete work. The cement was thoroughly tested with standard sand and found satisfactory. When everything was ready, an active start was made, and considerable concrete was placed before any doubts arose; it would not set up, however, in a week's time (or longer, it proved), so the cement was immediately tested again, with favorable results, and then some of the sand was examined. On the washing test it was noticed that a slight opalescence was imparted to the water, remaining in suspension several days, but leaving practically no deposit on sedimentation. The cement was then tested with this sand before and after washing, and the trouble at once located. The sand and gravel were both washed thereafter, and good results followed.

Table No. 3, on page 17, is added showing the tensile strength of cement mortars in the proportion of 1 part sand to 1 of cement, by weight, for Rosendale or natural cements, and 2 parts sand to 1 cement for the Portland. A siliceous sand was selected for this test, carefully screened to the sizes noted, and combined in the proportions given in the table. The test was made to determine the relative value of sand grains of different diameters, in combination with cement, and also to study the effect upon the tensile results of adding fine material.

Few unwashed natural sands are free of dust, of a loamy or clayey nature, containing high percentages of organic material,

TABLE No. 3. — TENSILE STRENGTH OF CEMENT MORTAR WITH SAND GRAINS OF DIFFERENT DIAMETERS.

Results given are the average of six briquettes.

| SAND GAGE PER CENT. USED. | | | | NATURAL CEMENT MORTAR 1:1. | | | | | | | | PORTLAND MORTAR 1:2. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Water per cent. | "Union." | | | Water per cent. | "Hoffman." | | | Water per cent. | "Giant." | | |
| No. 30. | No. 20. | No. 100. | Fine. | | 7 days. | 28 days. | 6 mos. | | 7 days. | 28 days. | 6 mos. | | 7 days. | 28 days | 6 mos. |
| 100 | .. | .. | .. | 17 | 156 | 193 | 352 | 15 | 115 | 163 | 314 | 10½ | 286 | 288 | 412 |
| .. | 100 | .. | .. | 17 | 151 | 194 | 349 | 15 | 118 | 146 | 286 | 10½ | 294 | 331 | 473 |
| .. | .. | 100 | .. | 17 | 153 | 187 | 340 | 15 | 91 | 110 | 257 | 10½ | 201 | 226 | 294 |
| .. | .. | .. | 100 | 17 | 100 | 123 | 307 | 15 | 71 | 76 | 186 | 10½ | 129 | 159 | 223 |
| 80 | 10 | 10 | .. | 17 | 154 | 210 | 358 | 15 | 94 | 124 | 301 | 10½ | 361 | 380 | 486 |
| 70 | 15 | 12½ | 2½ | 17 | 142 | 190 | 332 | 15 | 86 | 107 | 254 | 10½ | 301 | 303 | 428 |
| 60 | 20 | 15 | 5 | 17 | 143 | 192 | 342 | 15 | 83 | 107 | 285 | 10½ | 307 | 311 | 419 |
| 50 | 25 | 17½ | 7½ | 17 | 140 | 208 | 345 | 15 | 80 | 89 | 291 | 10½ | 391 | 400 | 538 |
| 40 | 30 | 20 | 10 | 17 | 133 | 197 | 362 | 15 | 90 | 82 | 296 | 10½ | 350 | 355 | 475 |
| 30 | 25 | 30 | 15 | 17 | 123 | 191 | 329 | 15 | 78 | 77 | 266 | 10½ | 362 | 359 | 478 |
| 20 | 20 | 40 | 20 | 17 | 128 | 199 | 318 | 15 | 66 | 73 | 285 | 10½ | 317 | 374 | 480 |
| 10 | 15 | 50 | 25 | 17 | 122 | 201 | 324 | 15 | 68 | 72 | 221 | 10½ | 291 | 354 | 488 |
| 50 | .. | .. | 50 | 17 | 108 | 193 | 317 | 15 | 62 | 70 | 239 | 10½ | 247 | 287 | 351 |
| 50 | 50 | .. | .. | 17 | 154 | 222 | 323 | 15 | 82 | 107 | 316 | 10½ | 440 | 408 | 542 |
| 50 | .. | 50 | .. | 17 | 150 | 210 | 344 | 15 | 78 | 88 | 290 | 10½ | 309 | 336 | 438 |
| 25 | 25 | 25 | 25 | 17 | 125 | 183 | 302 | 15 | 74 | 68 | 250 | 10½ | 279 | 337 | 447 |
| | Crushed quartz. | | | | | | | | | | | | | | |
| | | | | | | | 3 mos. | | | | 3 mos. | | | | 3 mos. |
| 40 | .. | 60 | .. | 16 | 179 | 256 | 355 | 14 | 93 | 100 | 142 | 9½ | 257 | 331 | 351 |

MEMORANDA. — All proportions and percentages determined by weight. Natural sand used, first passed through No. 8 screen and residue excluded. No. 30 sand passed No. 20 screen and caught on No. 30 screen. No. 20 sand passed No. 8 screen and caught on No. 20 screen. No. 100 sand passed No. 30 screen and caught on No. 100 screen. "Fine" is clean white sand sifted through the No. 100 screen.

and in specifications calling for sand clean and sharp and free from fine material, the importance of excluding this deleterious agent is recognized, but it is not always possible to enforce this exclusion absolutely; and from mechanical analyses of a large number of samples, and casual inspection of sand in use at various points, I am satisfied that much sand is used that contains 5 per cent. of dust, and a good deal that carries as much as 10 per cent., and even more in some instances.

The fine material passing the 100-mesh screen used in this test was obtained from a clean, white, siliceous sand; and if, with increasing amounts of this material, a falling off in tensile results appears, it can in no sense be taken as a *measure* of what would follow by using sand containing a dust of loamy or clayey nature, but it is in a way suggestive. The cements used in this test were of the same sample as in the other tests previously referred to.

The sand mortar test is the true basis upon which to judge the value of a cement, and I believe the proportion of sand to cement should be the same as that employed in the actual work of construction. Unfortunately, this was not carried out in the above test of the natural cements for the reason that results were desired for comparison with results of previous tests in the same laboratory, in which the crushed quartz or standard sand was used in the proportion of one part sand to one of cement.

Explanation of the results is hardly required; it will be noticed, particularly in the case of the natural cements, how uniform and constant is the falling off in strength at the 7-day period as the amount of fine material increased. This tendency, in the case of Union cement, disappears at the 28-day period, at which time rather remarkable uniformity is found in all the combinations, except the 100 per cent. fine; serious retardation in the improvement of the Hoffman, with the increase of fine material in the sand, is noticed between the 7-day and 28-day periods, the mixtures containing over 5 per cent. fine remaining almost latent for this time, three of the combinations showing an actual loss, while four make a small gain, the average gain being 2 pounds; a rapid recovery is found, however, in these combinations between the 28-day and 6-months' periods, and it is to be regretted that longer time tests were not made.

A tabulation of the results, excluding the series in which all fine and crushed quartz were used, is herewith given:

| | 7 Days. | | | 28 Days. | | | 6 Months. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Aver. | Max. | Min. | Aver. | Max. | Min. | Aver. | Max. | Min. |
| Hoffman..... | 84 | 118 | 62 | 99 | 163 | 70 | 277 | 316 | 221 |
| Union ..... | 139 | 156 | 108 | 198 | 222 | 183 | 336 | 362 | 302 |

The effect of the fine material upon the Portland cement is not so noticeable, even at the shortest period, except in the series with 100 per cent. and 50 per cent. fine, and no parallel can be drawn between the test with Portland cement and the results with Rosendale cement, using the same combinations of sand.

Cement users are coming to select their cements with more discrimination than ever before; their increased knowledge of the subject, and the more extended use of the material, show this to be necessary, and the natural result, owing to the struggle for commercial supremacy among the manufacturers, will be a better and more uniform product.

The chemistry of cement is an intricate problem, and an academic knowledge of it without sufficient practical experience has resulted and will result in much trouble to the manufacturer and user as well.

It is well said that " Experience is the best teacher."

## DISCUSSION.

Mr. Frank L. Fuller. I have had some experience in the use of concrete in the construction of reservoirs, mostly covered reservoirs, and its superiority in that kind of construction is very great. With brick and stone fixed methods of construction must be followed, for the material can be used only in certain ways, but with concrete we have a wider range. It is also true that to a greater degree unskilled labor can be employed, and this means a reduction in the cost of the structure. I think that better reservoirs can be constructed for the same amount of money, of better design, and of larger capacity, than could be built several years ago, even when prices of labor were less than they are to-day. This material is particularly well adapted for use in covering reservoirs and similar structures. The time for-

merly required to cover such a structure with brick can be reduced probably one half or even two thirds by the use of concrete, and the result will generally be better.

I think the point was well taken in regard to the separation of the cement from the aggregate in the case of too wet a mixture. Of course the tendency is, when the mixture is too wet, for the stone and sand to separate from the cement. Nevertheless, some work that I have done where the mixture has been very wet has been entirely satisfactory. A better face can generally be obtained to exposed work by using concrete that is rather wet.

PROF. WILLIAM P. MASON. Mr. President, I should like to ask for a little information with reference to a matter which came up in connection with the cement question not so very long ago. You will remember that Hillebrand and others published in the *Engineering News* some years back methods for the examination of cement from the chemical side, but, so far as I can find out, they did not differentiate between the combined silica and the mixed sand. Now the question which came up of recent date was whether certain cement bricks were up to the specifications. The specification called for a certain percentage of sand in the finished brick. I do not know how to make the determination of sand as against the rest of the silica except to separate them physically; and after the thing has once set it isn't an easy matter to physically separate the sand from the comminuted brick. The results are a good bit unsatisfactory. I would like a little information upon this point,— that is, the determination of sand in a set cement brick.

MR. LARNED. I will admit that there is a good deal of mystery about that, and it has feazed a great many very careful observers. An occasion for that determination arose in Boston within a comparatively short time, when the question of the proportions of concrete was raised by one of our city authorities, and some of our well-known experts were selected as a committee to examine the concrete and report on the proportions. The only way that I know of by which a close approximation — and it is only an approximation — can be made, is to determine the lime. We know that in the standard brands of Portland cement the pro-

portions of silica and lime are fixed within pretty close limits. They have to be to conform to the standard specifications. With the lime determined, and a proper allowance made for the silica to combine with the lime, then allowance can be made for the added silica, which is the sand. It is only an approximation, but it is the closest which can be made, I think.

There is one thing about consistency of cement which I did not touch on, which may be of interest to you. The bulk of concrete used in years past has been hand mixed, and in very many cases to-day it is necessary to so mix it. But I am very glad to see mechanical mixing coming more generally into use and being more generally required. It is a very difficult matter to combine sand and cement. They are naturally repellent of each other, with entirely different physical characteristics, and it takes vigorous work to combine them. You well know that in practical stone laying or brick laying operations the mortar tender is selected for that work who is a good, big, strong, husky fellow who can keep his hoe working in the mortar tub, and the more he works the mortar, the more he cuts it and churns it and whips it with his hoe or spade, the better condition it is in for the brick mason to lay his stone or his brick in. It is fatter. Now that quality of fatness means that the cement and sand are well combined, well incorporated with each other. In the case of hand-mixed concrete, where a dry mixture of cement and sand is first made, and then combined with the stone and the water added afterwards, the very first application of the water to that mixture means separation between the cement and the sand. You can see it, it is visible, and it is almost impossible in the presence of a coarse aggregate to bring the materials together again with shovels. They are, of course, knocked together in the hand-turning, but as a rule hand-turning is indifferent; the material is just rolled over. If it was slapped down, getting somewhat the same action that we get in mechanical mixing, it would be better.

To show how less water can be used and produce a concrete of quite a wet consistency, I might remind you of this: in mechanical mixing, if you use, for instance, twelve per cent. of water and hold it in your mixer for four or five or six additional

turns, it will compare very favorably in consistency with concrete in which you might have used sixteen per cent. of water and turned it out in a shorter time. It will be just so in hand mixing. You well know that concrete on the board oftentimes looks fairly dry, but by the time it is in the forms and subjected to ramming and spading and forking it flushes. That is due to the additional working. That same thing happens in the mechanical mixer and makes possible the use of less water.

MR. LEONARD METCALF. One question occurs to me to ask Mr. Larned, and that is, if he made any determination of the character of the foreign material which was washed out by the water in this New Brunswick case of which he told us?

MR. LARNED. There was no analysis made. It appeared to be of a clayey nature. That was sufficient, and inasmuch as it seemed to be accountable for the trouble no further interest was felt in it.

MR. WILLIAM E. FOSS. I should like to ask Mr. Larned whether he can tell us the cause of this little efflorescence which sometimes appears on brick masonry, whether it is due to the cement or the bricks or to lime, if they use it, or the coloring matter which is sometimes added?

MR. LARNED. Efflorescence is usually due to the washing out or dissolving of the alkalies in cement, soda, potash, and magnesia, and, as a rule, is more noticeable in Rosendale cements than in Portland cements, particularly the Portland cement of present manufacture. It is more pronounced, of course, in wet or damp locations, and has been successfully resisted by the application of waterproofing compounds, either in the mortar or on the exposed surfaces of the work.

Efflorescence sometimes originates or is added to by impurities in the brick, and occasionally it may be detected, not only through the joints of the brick work, but on the face of the work; this is due to absorption by the brick of the impregnated water from the mortar.

# THE EXPLOSION OF THE SARATOGA SEPTIC TANK.

BY PROF. W. P. MASON, TROY, N. Y.

[*Read December 12, 1906.*]

On January 26, 1906, the cover of one of the four septic tanks of the Saratoga sewage plant was totally wrecked by explosion. The tank covered an area of $91\frac{1}{2} \times 51\frac{1}{2}$ feet, and was built of concrete, with a concrete cover supported by columns of the same material.

Six manholes pierced the cover, and these were closed by disks of cast iron held in place by their weight alone.

The explosive effect was uniformly distributed, the entire cover having been sheared from the side walls and from the supporting columns. Although the iron manhole covers were thrown to great heights, the heavy concrete roof of the tank probably did not rise over 10 or 15 feet and then fell back in a state of utter ruin.

At the time of the explosion, one of the local theories advanced to account for the disaster was the malicious introduction of some high explosive. Aside from the improbability of any one venturing to commit such an act, the character of the explosion renders that theory inadmissible by reason of the fact that a high explosive would have caused serious local shattering of some one part of the structure and not a wreck of great uniformity over the entire area of the tank. It is now pretty generally admitted that the cause of the accident lay in the firing of an explosive mixture of septic gas and air.

The question is, How was the match applied? The location of the plant is in a remote spot and there was but small opportunity for the act of some passing smoker to have occasioned the trouble. In the opinion of the writer the primary ignition was caused by phosphine.

We all remember the timeworn lecture experiment wherein that spontaneously combustible gas is permitted to bubble through water and burst into flame when the surface is reached. Could

a small portion of phosphine have been generated by the action of organic matter upon the phosphates present in sewage, then the flame following its escape from the liquid of the septic tank would surely have been sufficient to have kindled any explosive mixture of gases which might chance to have been present. Can such a formation of phosphine be looked for? It is certain that I should not care to attempt a chemical equation to represent the reaction, but it is equally certain that I have upon one occasion observed large bubbles of gas, each the size of an orange, rise from the river bottom off the New York City docks near the sewer outfalls and that such bubbles did burst into flame upon breaking the surface.

The suggestion that phosphine was the cause of the Saratoga septic gases becoming ignited seems reasonable, and the question arises, What is to be done to guard against a repetition of the accident?

Allowing the probable rarity of phosphine formation, yet the possibility of its appearing is ever present, and we consequently look for safety toward the prevention of an explosive mixture of air and septic gases. It is scarcely news to tell you that, given a combustible gas, the mixture of the same with air will not be explosive when the mixture is made in all proportions.

As shown by Kinnicutt, the septic tank gases commonly contain about 75 per cent. marsh gas, with the balance of practically non-combustible materials. For complete combustion, marsh gas requires ten times its own volume of air; therefore, on the above percentage composition, 1 000 cubic feet of septic gas would require 7 500 cubic feet of air to burn it, making the total volume of explosive mixture 8 500 cubic feet. Any decrease or increase of the above proportion of air would lessen the intensity of explosive power, until finally a non-explosive mixture would result.

Sealing of septic tanks, as practiced during the early days of the art, has been abandoned, and air can now gain admission to the space between the cover and the sewage. It would seem wise, therefore, to so order the ventilation of that space as to keep the evolved gases continually so diluted with air as to avoid the formation of an explosive mixture.

PLATE I.

THE SARATOGA SEPTIC TANK AFTER THE EXPLOSION.

## DISCUSSION.

PROF. LEONARD P. KINNICUTT.* I agree with Professor Mason in a great deal that he has said, and do not believe the explosion was caused by the introduction of an explosive into the tank. There is no question that there may be often an explosive mixture of gases in a septic tank, composed of methane generated from the decomposition of organic matter in the sewage, and of atmospheric oxygen, and the explosive force of this mixture when ignited would depend on the ratio that existed between volumes of the methane and the oxygen. The important question is, How did this mixture become ignited? Professor Mason believes that the ignition was caused by the formation of the phosphite of hydrogen, which is a liquid at ordinary temperatures, and which immediately takes fire when coming in contact with oxygen.

Theoretically, this explanation is a perfectly reasonable one. In sewage there is a comparatively large amount of calcium phosphate, and also what are known as reducing bacteria, — bacteria which take away oxygen from various mineral substances. For instance, we know that nitrates are reduced to nitrites and sulphates to sulphides, and there may be a variety of bacteria that reduce calcium phosphate to calcium phosphide, which would cause the formation of the liquid hydrogen phosphide. If this liquid phosphide were formed it would ignite spontaneously, and might thus have been the cause of the explosion. There is, however, one objection to this theory, which is, if phosphates in sewage are reduced to phosphides, we ought to be able to prove the fact by laboratory experiments. We can prove that nitrates are reduced to nitrites, that sulphates are reduced to sulphides, yet so far we have not been able to obtain phosphides from phosphates, and though I have made very many experiments with sewage sludge, I have so far failed to obtain any trace of calcium phosphide.

These experiments are still being carried on in my laboratory, and may yet give positive results. Still, until we are able by laboratory experiments to show that there are phosphate-reducing bacteria, a simpler cause of the explosion may be considered,

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namely, that the explosion was caused by a lighted match or smoldering cigar accidentally coming in contact with the gases in the tank. According to Professor Mason's account, one of the employees of the sewage plant had just stepped off the top of the tank when the explosion occurred. Of course this may only have been a coincidence, still I do not think that anything that Professor Mason has said precludes the idea that this man was the cause of the explosion, that he was smoking or had lighted his pipe while on the tank and had thrown either the smoldering ashes from his pipe or the still lighted match in such a way that it might have caused the ignition of the gases inside the tank. This explanation seems to me more probable than that the explosion occurred through the formation of liquid hydrogen phosphide.

PRESIDENT SEDGWICK. I take it that Professor Mason only intended to suggest his explanation, and not to consider it as established or proved; but it does seem to me that his observation in New York is of very great importance. If a man has seen a river taking fire, he has a right to assume that there is something there which sets it afire, and it does seem to me that such an observation by such an observer ought to have great weight.

Mr. Eddy, I think, has had some experience along this line in Worcester, and we would be very glad to hear from him.

MR. HARRISON P. EDDY.* I realized some years ago, when I was trying to master the subject of chemistry under the instruction of the learned gentleman at my right [Professor Kinnicutt] that there was a good deal of theory about it, and to-day I am convinced that I was entirely right at that time, although it was then very difficult to convince him that that was true. [Laughter.]

This theory of Professor Mason's is certainly exceedingly interesting, and is worthy of very careful consideration and study; because, if what he suggests can happen, — if it is possible that that thing can ever happen, — we are up against a pretty stiff proposition, not only in connection with septic tanks, from which for safety we can omit the covers, but with our sewers and our cesspools and the deposits of mud under our wharves and under some of our buildings. It is a question if we shall be safe any-

* Superintendent of Sewers, Worcester, Mass.

where, except out in some place like the vicinity of the Saratoga disposal works where there are not many neighbors.

It does seem a little strange that we should have been dealing with septic tanks, where we have this gas all the time, and where we have the phosphorus all the time, for so many years, and that we never should have met just these conditions before. We are familiar with the fact that bubbles of gas come up on our septic basins, — large areas of the water are covered with bubbles of methane, — and why is it that they are not ignited? Why is it that we have never seen them burning in the open air? If there is a gas coming up which produces a flame, how does it happen that this thing can be constantly with us and yet never before have produced any effect which has been seen?

There are a number of things which it would have been interesting to have learned to-day about that explosion in Saratoga. We should like to know, for instance, whether the attendant was a man who ever smoked; whether he had a friend with him who ever smoked; whether he ever used a lantern in examining the tank, and various things of that kind. I presume the reply to all that might be that the man didn't smoke and that he didn't have any matches with him that day; but if he did it is very possible that he might have dropped a match which might have ignited a piece of paper or something which dropped into the tank. There are a great many possibilities.

When I was reading about this explosion some time ago I was very much interested, because I had mentioned in one of my reports the possibility of explosions in septic tanks, — not due to phosphine gas, however, — and it occurred to me that human nature is a pretty doubtful proposition, and any one who has had to deal with men in charge of filter plants, or in charge of gangs of men, knows that it is difficult sometimes to get at the real facts. To illustrate, I will just mention this incident which occurred some little time ago in connection with one of my foremen, who is a very trustworthy man, and whose veracity I ordinarily wouldn't question very much. I went upon the job one day, and after looking at him carefully and observing signs of intoxication, I said, " Pat, how many men have you got here? " He had some 30 or 40. " Well," he said, " I think I have got 14."

I said, " Pat, what is the matter with you? You have been drinking? " " No, sir, haven't taken a drop." [Laughter.]

Now that is the thing we are up against all the time in handling men; and while this Saratoga man may say that he did not have a match or lantern or cigar or pipe, there is still the human element which enters into the problem. I think Professor Mason's theory is very pretty, but I don't know but there is, at least, just as much ground for thinking that there might have been ignition from some outside source.

PROFESSOR MASON. Mr. President, I cannot help but wonder how high that man would have gone had he touched the tank off with a lantern or a pipe. You see there was no chance of anything getting in except through the manholes, and a man would of necessity have been on top of the tank in order to have dropped anything into its interior.

MR. JOHN A. GOULD.* I think that Professor Mason is right about this. Our chemist, Dr. Wing, has made numerous experiments trying to ignite explosive mixtures with a cigar. We have signs up all around our works, " No smoking allowed," but Dr. Wing has proved conclusively that it is impossible to light an explosive mixture of illuminating gas and air with a cigar, even when the cigar is at a bright glow; so I do not believe it would have been possible for a cigar, if it had been dropped into the tank, to have ignited the gas, unless it was more dangerous than illuminating gas.

PROFESSOR KINNICUTT. Speaking of the ignition of explosive gases, there is no question that an explosion in Lowell some six years ago of a mixture of carbon bi-sulphide and air was caused by a glowing cigar. And in experiments I made at that time a mixture of carbon bi-sulphide and air was easily set off, not merely by a lighted cigar, but also by a lighted cigarette. Furthermore, there have been explosions of septic tanks in England, and in two cases it appeared that workmen were smoking. Whether it was conclusively proved that the explosion was caused by these workmen I do not know, but it was so stated in the current literature.

MR. GOULD. I think the danger from smoking is in lighting

* Assistant Engineer, Boston Consolidated Gas Company, Boston, Mass.

a cigar or pipe; that is, it is the match which does the harm. That is the danger from smoking around gas works. It is not from smoking, but from dropping a lighted match.

PROFESSOR KINNICUTT. I should like to ask you, Mr. President, whether there are any bacteria, so far as you know from your laboratory work, that will reduce phosphates?

PRESIDENT SEDGWICK. I don't know of any, no. I should like to ask Mr. Phelps if he knows of anything of the sort?

MR. EARLE B. PHELPS.* None have come under my observation.

MR. E. S. LARNED.† Isn't it a fact that they have a good many explosions in sewer manholes?

PRESIDENT SEDGWICK. I was about to say that explosions in sewers are not rare, but in these cases very frequently — although not always — men have been down in them. This suggestion of Professor Mason's, — which I take it he offers only as an hypothesis, a working hypothesis, and a very interesting one it is, — if investigated and followed up might explain a number of things. I can't myself get away from that observation which he made in New York, when he saw the bubbles come up and burst into flame, and it seems to me that until those who are opposed to his ideas can explain that observation in some way, his hypothesis has at least one leg to stand on.

MR. FRANK A. BARBOUR.† I do not know how exact Professor Mason's knowledge as to conditions under which the explosion took place may be, but my information at the time was that there were two men at work on the disposal field. One of these, the superintendent, was in the laboratory; the other had just come off the top of the septic tank. It is some time since I have given much thought to the matter, and I have had no opportunity of visiting Saratoga since the explosion, but if my memory serves I had a letter at the time stating that the second man had just passed over the edge of the embankment at the time of the accident.

When I left Saratoga after building the works — after being in charge of the plant for a year — arrangements were made to continue the observations of depth of scum and deposit in the

* Massachusetts Institute of Technology, Boston, Mass.
† Civil Engineer, Boston, Mass.

tanks twice each week. These measurements were taken with a Fowler sludge gage through the openings in the roof of tanks. It would, therefore, not be an unusual thing for a cover to be removed and for the attendants to be working around the openings in such a way as to permit the entrance of some external agent accountable for the explosion. I am practically certain that both of the men who were on the plant smoked, and smoked pipes, and I think it very possible that in some manner a match was dropped into the tank, perhaps in the act of replacing the cover, in such a way as to postpone the actual ignition until the attendant, luckily for him, had time to retire beyond the danger limit.

My feeling is, therefore, that the explosion was caused by some external agency — perhaps by a match; possibly by spontaneous ignition of oily cotton waste. At all events this explanation is indicated by the fact that one of the attendants had within a few seconds of the time of explosion been on top of the particular tank in which the accident occurred. There are four (4) tanks exactly similar in construction, and it is a remarkable coincidence, at all events, that with the same sewage treated for several years, and at the time of explosion all four tanks filled with sewage of the same character, if the accident was due to a process of chemical decomposition inherent in the sewage, the explosion should have occurred at this time and in just the particular tank over which one of the attendants had been working or passing. While not intending to deny the validity of Professor Mason's explanation, — and his observation made at New York is interesting, — the burden of the proof is certainly on him.

It is a matter of common knowledge that under such conditions, as stated by Mr. Eddy, it is difficult to obtain information from men who have passed through such an experience, and I am not surprised that no actual reason for the explosion has as yet been put in evidence.

As a matter of interest it may be stated that the roof of the tank was replaced as originally constructed and the tanks continued to be operated in the same way as before the explosion — the opinion of the local authorities apparently being that the explosion was due to some foreign cause. Smoking around the tanks is, however, prohibited.

PRESIDENT SEDGWICK. I am reminded of what is well known to us all, that explosions in sewers are generally regarded as explosions of illuminating gas which has leaked into the sewer; and in what I said a moment ago about sewers blowing up, I meant that the match might have been phosphine, or something of that kind, although the cause is generally traced to some man who has gone down with a lantern or has thrown down a match. Dr. Mason's paper is a contribution to our theory of these matters, and I am sure is of interest even to those members of the Association who haven't much to do with sewage, because septic tanks are now common, cesspools are everywhere, and sewer explosions are frequent, so that we want to know all that is knowable about these things. It is true that we don't know it all yet. There are reductions and combinations and permutations of chemical compounds possible under the influence of bacteria which we do not yet fully understand. It is well to keep an open mind in these matters, and we are very greatly obliged to Professor Mason for coming here and broaching this interesting hypothesis. I take it that he does not care to make it any more than that at the present time. Does he wish to add anything to what has been said?

PROFESSOR MASON. No; there is nothing to be added. That tank blew up, and something touched it off. It may have been a match, as has been suggested, but I believe that it may have been phosphine, and one reason why I so believe is because of what I saw on the New York wharf. The bubbles there burst into flame before my eyes; that is beyond peradventure. Now if anything of that kind should have occurred in the tank, it would have accounted for what happened. That such a thing did occur I do not venture to say; I offer it only as a suggestion.

MR. BARBOUR. I should like to ask Professor Mason what he thinks of the possibility of such bubbles coming through the existing depth of floating scum, which, in the preceding year, you could almost walk on? I do not know how it was at the time of the explosion, but when we were taking our sludge measurements in the preceding year it was with difficulty that we could shove the gage through the dried surface of this scum.

PROFESSOR MASON. Well, inasmuch as the septic gas passes

through the scum, the presumption is that gases of other kinds will pass as well. Septic gas passes into the space between the top of the sewage and the under side of the cover, and the phosphine gas, if formed, would naturally follow the same channel.

MR. PHELPS. Mr. President, I am fully as much interested in the remedy for this thing as I am in the theory as to the cause of it. Professor Mason mentioned two possibilities, only one of which he considered, — that is, either having too much air to allow of an explosion, or too little air and too much gas. I think perhaps Mr. Barbour could tell us which would be the easier condition to maintain. It seems to me it would, perhaps, be the better way not to ventilate the tank at all, but to keep it air tight and prevent the admission of air, rather than to attempt to thoroughly ventilate it.

Particularly does this seem better in view of the fact brought out by Professor Mason that a mixture of 10 parts of air with one of gas is required for an explosion. It strikes me that this is just about the mixture which one would get by ordinary ventilation.

MR. BARBOUR. I think the ventilation of the tanks could be easily arranged; it certainly is a safe thing to do, and in future I shall make provision for ventilating the tanks, although there will be numerous instances where we will continue to use roofs as we are doing this year.

Experience has shown that open tanks are fully as effective as covered tanks, but it is to be remembered that in many places the appearance of the plant is the controlling factor. This was particularly the case at Saratoga, where the vicinity of the plant, while isolated, is a favorite resort of many of the summer visitors.

The covers on the tanks were simply of plate iron, about $\frac{1}{4}$ inch thick, and were not constructed so as to be air tight, being just set in a cast-iron frame. At the time of the explosion these covers may have been coated with ice in such a way that the gas was practically trapped under the roof. In certain experiments made in England, — described in one of the reports of the Royal Commission on Sewage Disposal, — no gas pressure in the septic tanks was found, the gas apparently diffusing itself through the masonry.

# METER REGISTRATION.

BY ARTHUR N. FRENCH, SUPERINTENDENT WATER COMPANY, HYDE PARK, MASS.

[*Read January 9, 1907.*]

In reading the JOURNAL of this Association for December, 1906, I was interested in a little paper presented by Mr. George A. Stacy on "Pumping without an Air Chamber" and the discussion upon it. In that discussion Mr. Stacy spoke of a happening in his experience, when one of his patrons thought he had discovered a water meter which was registering when no water was passing through. It occurred to me then that some experiences of mine along that line might be of interest to some of the members of this Association who had not happened to meet with the same difficulties.

One experience which I had was along the lines suggested by Mr. Stacy's friend. I did have a water meter which registered cubic feet of water on the dial when absolutely no water was passing through the pipes. Of course we all tell our patrons that it is a physical impossibility for a meter to register without the passage of water, but I have had three cases in my experience when it has occurred, and I have experimentally caused meters to register without the passage of water. It is an unusual condition when such a result is accomplished, and to do this experimentally it is necessary to understand how it is done, and to provide the necessary conditions.

The season of 1899 was a very dry one, and my company found it necessary to add to its source of supply and to its pumping plant. A tract of land in another locality was secured, wells were driven, a station built, and a pump installed. The wells were 21 in number, 2½ inches in diameter, and the pump was a horizontal direct-acting compound of 2 000 000 gallons daily capacity. It was and is so rigged that it could be operated as a duplex pump, or by changing the valve connections either side could be operated by itself. It was found best to always run the pump in this latter manner, as the 21 wells would not furnish water fast

enough to make it profitable to operate the pump as a duplex. The water plunger is 14 inches in diameter and the stroke 24 inches. The pump is operated at about 32 strokes, or 16 revolutions per minute. As our system is that of direct pumping, with a standpipe for the excess, the operation of this pump makes a considerable amount of fluctuation in pressure on our mains and piping system. There is a surge at every stroke, and the pressure will vary about 9 pounds at the pumping station, and a mile distant the fluctuation of pressure will be about 3 pounds.

We began to operate this plant regularly in December of 1899, and some time in the following year one of our patrons called my attention to the action of the water meter in his house, which, he declared, was registering water when none was being used. He said that he could hear the meter operate in the dead of night. Complaints that " there is something the matter with the meter " are of such frequent occurrence that the statements of my friend were not taken very seriously. He persisted, however, and I went to his house. Everything was all right. The plumbing was tight, no water was being drawn, and the meter was not registering. I thought the incident was ended, but in a short time I saw my friend again, and he repeated his statements. I visited the house several times, and at last I found the meter actually in motion. I saw it go, and heard the piston thumping gently at about the frequency of the strokes of the pump at the pumping station. I satisfied myself that no water was escaping at any point in the house. All of the water piping and fixtures were in plain sight. I watched the meter and it registered one tenth of a foot on the test dial in a few minutes. After that I went there frequently and noted these same conditions. Then I took out the meter and set another of the same make. That would register just the same. I reversed the meter, setting it backwards, and left it there twenty-four days, in which time it registered forward 240 feet. The meter was of a type which does not revolve backward.

Of course we soon thought that the pulsations of the pump might be the cause of the trouble, but the only way in which these pulsations could produce such an effect would be through the existence of an air chamber of considerable capacity in the

piping of the house, allowing each stroke of the pump to compress the air and force a little water in through the meter, turning the pointer on the dial forward. In the interval between the strokes the air chamber would force an equal quantity of water back through the meter, which could not turn backward. I examined the plumbing for such an air chamber, but could find nothing which could possibly provide such a chamber except a hot-water heating plant in the cellar. The house stands on high land, and the pressure on the mains at that point is only 30 pounds. The hot-water heating plant of which I spoke is located in the cellar, and furnishes heat for a small greenhouse and for four radiators on the ground floor of the house. Water is connected with this plant from the house pipes directly, and is left on all of the time, and there is no expansion tank, so that there is always a pressure of 30 pounds on this heating system, and when it is fired up the expanding water must be forced back through the meter to the street main. It has no check valve. I think there was an air cushion somewhere in the heating plant, though I could not find one. Air may have been trapped somewhere in the return pipes where we could not find it.

After satisfying myself that the meter did actually turn without the consumption of water, I took it off and substituted one the piston of which will turn either forward or backward, and have had no further trouble there.

I was not quite satisfied with the knowledge gained by observing the above case, and decided to make an experiment. I therefore rigged up a rude testing plant at our new pumping station, where the static pressure is 98 pounds, and the fluctuation due to the stroke of the pump, 9 pounds. I took a kitchen hot-water boiler and mounted it in a hydrant house. I attached a pipe to the hydrant nozzle, set a meter, and attached the other end of the pipe to the hot-water tank, from which there was no outlet. A picture of the arrangement is shown in Plate I. When the hydrant was opened, the hot-water boiler filled with water to within about 9 inches of the top, that 9 inches being compressed air, making a splendid cushion. With this arrangement I tested several kinds of meters. It will be noticed that the meter in the picture is an old-fashioned plunger piston meter. That ran

beautifully under the test, registering one foot on the dial every 1¾ minutes, or 70 strokes of the pump. Another meter registered a foot in 32½ minutes. I found that any type of meter which would turn backward would not register water under this test, but any meter which was so constructed that it would not turn when water passes through it backward, would register under that test. I found also that if a good check valve was set with the meter, no kind would register.

I have had two other cases of this same nature. In one case I found the air cushion in a long pipe running to a lawn hose faucet and another long line running to a stable, neither of which had been emptied of air when the water was last turned on.

Another rather mystifying experience which I have not yet fully worked out, but which I suspect is due to the same operation of the surge of this pump upon an air cushion somewhere in the piping system, is the peculiar action of a 2-inch meter on a fire standpipe. This is located in a block which has stores on the ground floor and flats on the two floors above. The standpipe is 2-inch, and has nothing connected with it except hose outlets on each floor, to which hose is always connected. There is no leakage, for if there was it would show on the floors. I have repeatedly examined the piping, and I believe there is no other possible outlet. No water has been used from this standpipe in the past six months, yet the meter now reads 1 847 feet *less* than it did six months ago. There is a regular decrease in the reading month by month. The meter is set correctly and is in good order, having been overhauled not long since. This meter is of the type which will turn either way; and I should like some member of this Association to explain how it can turn backward under the circumstances and not forward. It is possible that there is something in connection with the gearing which tends to drag a little when going forward, and allows free turning backward.

It is, indeed, a cold day when there is not some sort of a puzzle on hand in connection with meters. I once had an ordinary ⅝-inch meter which all at once began registering backward at about ten times the speed at which it should register forward. On removing it and overhauling, I found that one wheel in the intermediate gearing had become loose on its shaft, fallen down, and

PLATE I.

APPARATUS FOR TESTING METER REGISTRATION UNDER FLUCTUATIONS OF PRESSURE.

engaged a different pinion below, reversing the travel of the dial hands, and driving them ten times faster.

Another ⅝-inch meter set on a dwelling-house service puzzled us for some time by registering up to about 65 feet and then going back and commencing over again. It seemed to have a certain prejudice against recording above 65 feet on its dials. We watched it for some time. The owner of the house fell under suspicion, though he didn't know it. On taking out the meter and examining it, we found in the train of gears attached to the pointers on the dial one wheel which had one missing tooth.

In several cases I have had a meter become set so that it would not turn, caused by the wearing of the end of a shaft in the intermediate gear, so that its pinion would drop down a trifle and engage two gears at once.

I hope none of the gentlemen present will form the opinion from this little paper that I am opposed to water meters. The contrary is true. In our plant about 40 per cent. of the services are metered, and if I were a magician the other 60 per cent. would be within the year. I would rather have this little paper taken as an indication that meter troubles come to every one, and no person in charge of a water-works plant which is beginning the work of installing meters should become discouraged by puzzling things in connection with them. The puzzles will be found solvable, and it will be found that there are not more of them than is the case with almost any machine.

## DISCUSSION.

THE PRESIDENT. Now is your chance, gentlemen. Here is something right off the bat [laughter], and if you can't catch it you are not in the game. I am sure Mr. French will be very happy to have a lively discussion. Of course we want to hear from the meter men.

A MEMBER. Mr. Tilden has the ball, Mr. President. [Laughter.]

MR. J. A. TILDEN.* Of course freaks will sometimes appear in the best regulated families and among the best regulated

*Mechanical Engineer, Hersey Mfg. Co., Boston, Mass.

machines. I believe it is not an unknown thing for such a staid and reliable machine as a locomotive to start up of itself and run amuck. Somehow or other the throttle valve gets open, nobody knows how, and the thing runs away. Still we have a great deal of confidence when we ride behind one of these dignified and stately machines that we will get to our destination in due time, and the few occasions when they do run amuck do not discredit them in our confidence by any means.

There are in use in the United States to-day possibly somewhere in the vicinity of 2 000 000 water meters, and I venture to say without prejudice that, taken as a machine, taken as an instrument, taken as a class right straight through, they are reliable and are so regarded by the water works fraternity at large. These little things which Mr. French has told you about do happen, but it is very, very rarely. The conditions under which they occur are peculiar, and they have to be extraordinary. Mr. French has gone into the matter very carefully and explained to you just how these meters register when no water is passing through them. Of course that statement is not exactly true, for meters register because the water *does* pass through them, and they do not " unwind " the registration simply because they are of a type which can only operate by the water passing through them in the usual direction. Repeating, then, the meters of which he spoke registered because water did pass through them, but they didn't " unwind " when the water passed back through them.

There are several kinds of meters which will act in that way. It was at one time considered to be quite an advantage for a manufacturer to produce a water meter which was capable of registering in only one direction. Some inventors have gone so far as to put special ratchet devices on the gearing, so in case the meter was reversed by an unscrupulous water-taker, or a Chinaman [laughter,] he would have to pay for the amount of water which did go through, and couldn't unwind it so that the water company would owe him. I suppose if some of our good friends, the superintendents, were so disposed, they could tell of numerous instances where other types of meter, those which register equally well in either direction, have been maliciously removed from their connections and set in the wrong direction,

so that the registration has been very materially less than it was at the time of the previous reading, making virtually charges against the water department instead of charges against the consumer.

In systems where there is direct pumping, and where there is the liability of the formation of an air chamber, and one of the several kinds of that type of meter which Mr. French has described, it will work as he has shown. The air chamber in this particular case that Mr. French brings to your attention, that is, the one in the private dwelling house, is not far to look for. In a hot water system it is almost impracticable to fill the radiators completely full of hot water; there is no true circulation in the upper part of the loops of the radiators. The top part of every radiator is a true air chamber, so that with each pulsation of the pump there will be a marked flow of water into the system, and at each recession of the pump there will be a marked discharge from the hot water system back into the water works system; and a meter of that kind, — that is, the kind that won't unwind, — will go forward, as he says. He has gone so far and so carefully into the matter that he has explained fully how it may be avoided if you are ever up against that sort of a thing. Of course the simple presence of a check valve will prevent any possibility of working backward, when you are confronted with the air chamber problem.

In this particular case something is allowed which I think all water works superintendents will agree is extraordinary, that is, the direct connection of a hot water system in a private house with the water works system, without a check valve and an expansion chamber; in other words, allowing water works pressure to circulate throughout the hot water system, so that no expansion can take place without driving the water back into the water works system. The general plan, as you all know, is to provide an expansion chamber, or to go into a tank and then from the tank into the hot water system and then into an expansion chamber. The condition which Mr. French mentions was most extraordinary. In a great many places it would not be allowed, and I venture to say you would have to go a great way to find another such case.

He speaks of another type of meter. I might say here that I perhaps ought to have some reluctance to speak on this subject, because my good friend Mr. French is the superintendent of the water works in the town in which I live, and presumably no other meters are used in that town but my own. [Laughter.] I wish to say to you, however, that such is not the fact, and therefore my reluctance is not so great as it might otherwise be. Mr. French has had experience, as is stated in his paper, with a variety of types. There is no one type there which has gone through all his experiences, so I can speak on the subject in a broad way. He mentions a 2-inch meter which, due to the presence of the air chamber again, is steadily showing a less amount, month by month. That is a type of meter which will work both ways. That is, this particular meter is a current type of meter and will work either way, — by the water passing through it in the regular direction or with the water passing through it backwards. Now, being a current type of meter there is one direction in which it will work a little freer, a little easier, than it will in the other; that is to say, it will not register exactly the same amount of water forward that it will register backward, or *vice versa*. It so happens that this particular type of meter is a little more sensitive running in the reverse direction, so that while the meter is forced forward by the surging of the water against the air a certain amount, it recedes by the surging of the water in the other direction a little further back than where it started from in the first place, and the differential between the two is in favor of unwinding, which is the term Mr. French uses. Of course the condition is entirely abnormal there and is instantly relieved by the placing of a check-valve either in front or back of the meter. I don't know the name of the meter, and I am just talking in a general way because Mr. French said it was a current meter, and some of the current meters have this characteristic of measuring more in one direction than they will in the other.

The difficulties in connection with the intermediate gearing of which he speaks, that is, the wearing and dropping down of one gear into another, are common to all meters in which the motion of the piston is communicated to the dial by intermediate gearing. I think, however, I can say with confidence that it is

a most extraordinary occurrence. From my personal knowledge of and experience with thousands of meters, it is something which occurs, as you may say, only once in a generation. It has occurred, it does occur, but it is a most extraordinary freak, and occurs so seldom in the hundreds of thousands of meters that it may practically be disregarded.

The little incident about the meter which has such a strong dislike to register more than 65 feet without starting over again is really very funny. I can see how that might happen. I don't know whose meter it was, but it can happen to the dial of any meter made by any manufacturer. I apprehend it comes about in this way, and any one of you gentlemen can prove it by experiment. Suppose, if you please, it is a 6-dial meter; if you lock firmly the last dial, the last spindle, as it might possibly be by corrosion, and then undertake to wind it up, you get a very powerful spring action. One hundred thousand turns of the first spindle will make one turn of the last spindle, and with the last one rigidly fixed you can turn and keep on turning until the whole thing is a powerful spring, and the time comes when something has got to go, and that something is a tooth in the gear. The minute that tooth goes everything slips right back to its original place, everything goes right back to zero again, and proceedings start up as before until the broken tooth is reached and then the thing goes back again.

However, I am very glad that Mr. French does not bring up these things for the purpose of discrediting water meters, and I feel that neither as an associate nor as an active member do I need to stand here and apologize for what I believe, and what I am sure we all believe, is a most creditable record and a most creditable showing on the part of that marvel of mechanical ingenuity, the modern water meter. [Applause.]

Mr. George A. Stacy.* Mr. President, a few days ago my inspector came in and said, "We have got another mystery." Those mysteries go only as far as we make an investigation and search out the facts, and I can say that there has been no mystery about any water meter we have had yet that we have not been able to solve. In this case the trouble wasn't with a meter, but simply

* Superintendent of Water Works, Marlboro, Mass.

with the dial of the indicator on a plunger elevator, and the explanation was so simple that it shows how easily you can be fooled if you are not careful in making your investigation. This dial registers up to 10 000 000. The elevator has been in use perhaps four years and the indicator got up to several hundred thousand. The next time the inspector went there it registered 35. He came back and notified me, making the remark about its being another mystery. I said, " Well, the best thing you can do with that is to keep your eye on it; somebody has been monkeying with it." The next time he went there it had gone up from 35 to 95,000, and I said, " You had better take it out and bring it down here and we will examine it."

He brought it down. The cap that covered the face of the dial had been broken, and I set the indicator on the desk and began working it around, trying to find out if there was a slip in the gear or if a pinion had dropped down, but everything appeared to be intact. Taking hold of the hands and trying each one, and holding it up to a strong light, everything appeared to be in perfect order and in perfect mesh, and you couldn't start a thing anywhere. On most dials, as you know, in fact on all dials I had seen previous to this one, the hand on the end of the shaft is just put on and soldered, and if the solder breaks the hand becomes loose and will drop off at the least movement. But these hands were put on a little differently; a little more work had been put into them, and they were fitted on a little further; not exactly rivetted on, but so that the hand would turn clear around and not come off or show a break in the solder. They were stiff enough so you could move the gear back and forth and put about all the purchase on you would think ought to be put on to the hand without disturbing the joint.

The inspector came in at night and he says, " Have you found out the trouble? " I said, " No, I haven't; I guess we have got to look further than this." And just as I spoke I pressed pretty hard with my hand and I started one of the hands; and I found then that there were four of the high reading hands, which, by putting on pressure enough, I could keep turning around, but still they were tight enough to do the recording. The explanation was simply that, the case being broken, the everlasting small boy

had been playing clock with the thing, as we found afterwards; and he had set it so that sometimes they owed us and sometimes we owed them, and it got so we didn't know where we were. Thus the mystery was solved; and it was a very simple thing, like all the rest, when you get at the truth of the matter.

MR. EDWIN C. BROOKS.* Mr. President, speaking of connecting hot water systems directly with the water pressure, it becomes necessary in many apartment houses, where there is no room for a tank above the upper story, to put the hot water system for the house on to the direct pressure. Of course in Cambridge we discourage as much as we can the connecting of a hot water system direct, but nevertheless it is done frequently, and in order to give a satisfactory pressure of hot water on the upper stories of these houses it is necessary to do it.

We always calculate in setting a meter to make a canvass of the house and, if the hot water tank is connected directly to the water service, to put in a check valve. And there we often meet with opposition. We say to the householder, "We don't propose to furnish a drain for blowing off your hot water back into the main, and we don't propose to have you run hot water through this meter and ruin the discs, or anything of that kind"; so we put on one of the swing checks, and it has resulted in this: the cautious owners will go and purchase a 75-cent pop-valve and put it on to the hot water system and thereby make their plant a little safer than it would be otherwise. I think if check valves were more generally applied to all metered services it would result in a better condition of the meters, although I am free to say that we don't always have check valves which operate as well as we would like to have them. We endeavor to connect nothing but brass into the check-valve body, and in that way get rid of the corrosion that will always take place when an iron nipple is screwed into a brass fitting.

In regard to the registration of meters we all have complaints. An inspector will come in and say that a certain meter is not showing any use of water and we had better look into it and see what the trouble is; and we find that on some of the higher hands the pinions are stuck in the plates, and that they go up to a certain point

* Superintendent of Water Works, Cambridge, Mass.

where either the meter stops because it can't break the gear, or else a tooth of the gear goes. I must say that it is astonishing what power some of these little disc meters have for tearing things to pieces. I have often wondered at the amount of injury they can do to themselves, but still such is the fact. I think if our friends in the meter business would give us a meter clock, where the holes in the plates were bushed with something which would not corrode, a good many water works superintendents would rise up and call them blessed. [Laughter.] If you would go around and see the places where meters are set and the usage that they get, I think you would actually wonder sometimes that they did not stop from mere disgust at their surroundings. [Laughter.] But, as Mr. Tilden has well said, the modern water meter is a marvel of mechanical ingenuity and accuracy, and I think that any one who has to do with a large number of them will say that it would be hard to find a corresponding number of appliances, so intricately constructed as they are and put to such hard service as they are put to, that would do as well. [Applause.]

MR. GEORGE H. SNELL.* Mr. President, I have been very much pleased with this discussion and with Mr. French's paper, although I could not hear every thing that he said. All of our services in Attleboro are metered, and I sometimes think we know something about meters. From investigations we have made as to the effect of the vibration of the pump it seems to me impossible that a meter can turn without a discharge. There must be water going through in order to make a registration.

I remember a case about two years ago where a man who was a plumber and who used to repair our meters and thought he knew all about them, came and said he had a meter which certainly registered from the vibration of the pump. We went into his cellar and watched the meter for probably half an hour, and we found that it was registering; I think it registered some 10 feet during that time, possibly not so much as that. I said "There is a leak somewhere," but he thought it impossible. As the pipe ran underneath the concrete cellar bottom I suggested shutting it off, as there was a shut-off in front of the meter before the pipe passed

* Superintendent of Water Works, Attleboro, Mass.

under the concrete, and we found when it was shut off the meter did not register although we had the same vibration. What he did was to cut off his pipe underneath and piped overhead and in that way remedied the whole trouble.

The gentleman who first spoke referred to a locomotive running away; but it could not run away if the exhaust was stopped up; it would be impossible. The exhaust must be open to enable the engine to make a revolution. I believe those things should be considered as there is always some foreign trouble which we do not understand.

In regard to registration, we do most of our repairing; we have a good testing bench and a man who works continually on meters, and we find that most of the trouble is on the inside, either a little sediment, rust or some foreign substance, that stops the piston or the disc, as the case may be. Very seldom does the register bother us. My experience has been that while meters may run and register, they should be taken care of and cleaned out and repaired once in two or three years.

I saw one in Fall River a few years ago, which the man in charge of the meters had taken out and brought in, and there was really nothing left of it on the inside. He said the meter had been in for eighteen years, and I said, " How long do you think it has been registering? "

" I don't think it has registered," he said, " in the last ten years." [Laughter.]

I believe the main dependence of the water department, if you have a metered system, must be on the maintenance of your meters. In one city I know of, but which I will not name because I may not be able to state the facts just exactly as they were, they used to have a per capita consumption of 220 gallons per day. They investigated with the idea of increasing their water supply and employed an engineer who took the matter up, made an estimate of what the waste was, and as a result of the investigation they put in meters at an expense of about $35 000, and brought the per capita consumption down to somewhere in the vicinity of 85 gallons. The meters were set and no one knew anything about maintaining them or taking care of them, and in four years they had done nothing to the meters in the way of re-

pairing them, had not even taken them out when stopped, and as a result got back to 200 gallons per capita per day.

Now the only way to get income from the department, according to my idea, is to maintain the meters properly. Personally the only office work I do, outside of the correspondence and taking care of the necessary business, is making out the semi-annual bills. I charge on the ledger and the clerks in the office make the bills, and by being familiar with the charges, knowing the people and also the conditions, if the consumption is not as much as in previous months I invariably find the trouble. For instance, if they have been using $100 worth of water and it falls down to $65 worth, I notice from the meter readings that it has dropped from 15 000 to 12 000, 10 000, 8 000, 5 000, or 2 000, and that shows it is time the meter was taken out and changed.

I believe there should be some one at the head of every department who should be familiar with these conditions. We have 1 800 meters but, if there were 5 000 or more, there should be some one, even if it has to be divided into different sections, who will be responsible for each section and who will know the conditions.

In regard to connections where hot water is liable to back up to the meter, we had such a case in South Attleboro, — Sadler Brothers. They had a meter and paid about $25 or $26 each six months. When I came to the office it seemed to me that was a very small amount for boiler use and for a jewelry shop, and I inquired into it, and they said every time they read the meter it had stopped, so they simply got readings of a few hundred feet and made an average from that. After investigation we put in a check valve at our own expense and in the next six months we got $105. We kept along at $105, $115, $120 each six months, but later it stopped again, when a second check was put in with a valve between the two, so we could clean them, as sediment would get in them and let the water back. In that way we got $225 to $230 each year against probably $50 or $55 formerly.

Mr. John C. Whitney.* Nearly all of us must have had experiences in regard to meters registering when apparently no water was passing through, similar to those related by Mr. French. I

* Water Commissioner, Newton, Mass.

remember distinctly my first experience in that line. The complainant was a member of the water board. He came into the office and said that his meter was registering when no water was being drawn, and he knew it. Of course we received his complaint with polite incredulity, but offered to investigate the matter, and I was sent up to the house to make the investigation. The gentleman said he had to be away for a while and the family was not at home, but here was the meter and there was the plumbing system and I could make any investigation I chose and see what could be found. I went through the house and everything was tight, nothing running, not even a drop. I watched the meter and in the course of a few moments it moved up a tenth of a foot. I made another trip about the house to make sure that there wasn't something running, but no sign of trouble anywhere, and in the meantime the meter had moved ahead a tenth more. There was a shut-off on the pipe line within, possibly, 15 feet of the meter. I shut that off, made sure it was tight, that the water wasn't leaking by and watched the meter and in about five minutes it moved up another tenth. I found it was recording at the rate of about a foot and a half an hour.

The meter was one in which the registering mechanism can only move in one direction, of the ratchet-gear type, and was situated within half a mile of the pumping station on very high ground. The service pipe supplying the house was, I should think, 200 or 300 feet in length, and the pressure in the cellar probably not more than 10 or 12 pounds. There was no question whatever but this meter was working on pump pulsations. There was no air cushion and no way I could see by which the water could be forced through the meter and register, but it was doing it. We substituted for that meter one of a type which could record the reaction as well as the action, and after that there was no trouble.

Mr. John H. Flynn.* We have heard about what funny things meters are, but nobody has said anything yet about the men who read the meters. A friend of mine came to see me within six weeks and he said, "How much ought I to pay the city of Boston for what water I use?" I said, "How many rooms are you occupying?" He told me he was occupying three rooms in a

* Boston Water Department.

building. "How many fixtures have you got?" "Well, I have got a water closet and a sink." "Do you use water for any mechanical purpose?" "No, only for washing hands once in a while." I said, "I should judge somewhere about $7 or $8 a year would be fair." He said, "Well, I should judge that would be about fair; but how would $140 a year strike you?" I said, "That would be a little too high." He said, "I have got a private meter on the pipe I use, and for three quarters now I have paid $35 each quarter. Now, will you be kind enough to look at that meter for me?" I told him I would the first time I had any leisure; and as we are very busy in the water department, as you know, I had to wait a little before I could get a chance to go up and look at the meter. It seemed to be all right, and according to the way I read it he had used 27 cents' worth. I asked him who read the meter, and he said the janitor of the building. I asked him who made out the bills, and he said the janitor did. I asked him if he would be kind enough to let me see them, and he showed me the bills, each dated the first of the month ending the quarter, and I found that they all read just alike, that the number of feet he had used was just the same in every case, and it figured out that there was $35 for him to pay. So I saw the janitor and asked him who taught him to read meters. He said he learned how to do it from a book. [Laughter.] I said to him, "How do you make it that exactly the same amount of water is used every quarter?" He says, "Well, I always find the hands in about the same place." [Laughter.] Said I, "In other words, you think that the hands make a complete revolution?" "That is it," he says, "that is the only way it could happen." I took the meter out and tested it and I found that the meter was off only 500 per cent. in favor of the consumer. [Laughter.] The trouble simply was, that the gears had got twisted around in such a way that they didn't mesh very well and the meter would run along without turning the hands at all. I notified through him the manufacturers of the meter and they very kindly took it out. I haven't seen him since, but I guess he hasn't been paying quite so much as he used to.

MR. FRANK L. NORTHROP.* We had a funny experience once with a man who ran a bottling establishment. According to the

*Mechanical Engineer, Union Water Meter Co., Boston, Mass.

meter we owed him every month about $25. They were using water night and day all the time, there was a stable back of the building, and he had a great many fixtures in the building. We found that his system was all connected through the building. He had one ¾-inch and two 2-inch meters. After a while we found that the pipe going to the stable had a leak into a blind sewer, which no one could see, and the two 2-inch meters were furnishing water for the building and also for the sewer backward through the ¾-inch meter.

MR. J. C. HAMMOND, JR. I think, Mr. President, that if you should find our meeting dragging a little later, it would be a good plan for you to ask our meter friends to tell us who makes the best meter. If anybody asks me who has the best wife in my town I can tell him right off, but if anybody asks me who makes the best meter I confess that I am up against it. There are lots of good meters and some poor ones, but I had rather have a poor one than none. They are good scarers. [Laughter.] A red flag won't keep a man from being run over if he persists in standing on the railroad track, but if he has any brains he will keep off the track when he sees the red flag; I had rather have a tomato can and a dollar watch on a supply pipe than not have anything. [Laughter.]

# EXPERIENCE WITH "UNIVERSAL" CAST-IRON PIPE.

## TOPICAL DISCUSSION.

[*February 13, 1907.*]

President Whitney announced that an inquiry had been received from a member of the Association, who was unable to be present, asking for some information in regard to "Universal" pipe, and invited any one who had had experience with it to state the results that had been obtained.

MR. JOHN H. COOK. The Passaic Water Company of Paterson, N. J., has laid two lines of this pipe, 12 inches in diameter, across the Passaic River a mile or two above the town, and we have found it satisfactory. The reason we bought it was because it was convenient to lay under water. The pipe is made with a ground joint, the lengths are fastened together with bolts and lugs, and the pipe can be laid with unskilled labor. As a matter of fact, this line of pipe was laid by divers in a trench which was dug across the river under 6 or 8 feet of water in some places, and they could put it together very conveniently by means of the bolts and lugs. When the line was tested it was found to be tight and it has remained tight up to the present time.

At Little Falls, N. J., five or six miles up the river above Paterson, two or three miles of this pipe was laid by Mr. A. W. Cuddeback, a member of this Association, about two years ago, and I think he has found it satisfactory. It is a pipe which may be laid very rapidly by men who are not particularly skillful. I remember seeing up there one day a piece of trench which I should say was 250 feet long, and that length of 6-inch pipe was laid by two Italian laborers that day, and when tested it proved to be reasonably tight. I think they had to do some little adjusting afterwards, but not much.

The makers claim that the pipe may be laid considerably out of line without leaking, and that it may move or settle somewhat in the trench without leaking. I believe this pipe was bought at

Little Falls not because they preferred it, because it was a new thing then, but because they could get it very promptly, and the people who were putting it on the market were very anxious that more of this pipe should be laid.

THE PRESIDENT. Is lead used in the joints?

MR. COOK. No; no lead is used in the joints at all. They are ground joints. There is a male and female joint, and they are just put together and bolts fasten the pipe together by means of lugs which are on the side of the pipe. We laid two lines of 12-inch pipe across the river, and the pipe at Little Falls I think ranged from 12 inches down to 4 inches.

THE PRESIDENT. And that was also under a light head?

MR. COOK. No; the Little Falls pipe, I think, was at one time, indeed, has at different times, been under quite heavy pressure, because we drop the pressure through a regulator, or through a pressure-reducing valve, to this Little Falls line, but I think once or twice the reducing valve got out of order and put the total pressure on the pipes, and I think at that time they had no trouble with it to speak of. The Little Falls pipe system is now under a pressure of about 100 pounds, that is the pressure at the water company's office on the main street of the village. I think they have had one or two leaks, but no more than I should expect in any system.

A MEMBER. How long are the lengths of pipe?

MR. COOK. The lengths are short. As I remember, they are about 6 feet. Anyway, it comes in short lengths, and of course they have specials of different kinds which are contrived for this pipe.

A MEMBER. How does it compare in cost?

MR. COOK. It is much lighter, it does not weigh as much as ordinary cast-iron pipe, but the makers claim they use a much higher grade of iron. I don't know about that, however.

MR. COGGESHALL. Will it take the place of flexible-joint pipe?

MR. COOK. The makers claim it will, and it seems to be very satisfactory. As we laid it across the river, of course it was more or less out of line, and it was laid under the water by divers.

A MEMBER. What is the remedy for leaky joints?

MR. COOK. I suppose it would be to dig up the pipe and tighten up all the bolts. I have had no experience beyond what I tell you.

A MEMBER. As I understand it, the pipe you laid across the river was under about 6 feet head of water in the river?

MR. COOK. Yes.

A MEMBER. What pressure did you have on the pipe?

MR. COOK. I think the pressure was 30 or 40 pounds, but the Little Falls pipe system was under considerably heavier pressure than that.

MR. CHARLES W. SHERMAN. I remember that a few months ago some one, I think it was a member of the Association, told me of a case where he had used the Universal pipe across a marsh for a distance, as I remember it, of about half a mile. I can't remember who it was who told me, or where the place was, but he said he had found it entirely successful. It was easy to lay, and it obviated the trouble he would have had if he had tried to make lead joints in that wet locality.

The difficulty, if any, with this pipe, seems to me to be in the durability of the bolts. As I remember it, there are two bolts which draw the lengths together and make the joint, and so far as I know none of this pipe has yet been in service long enough to give any reliable data as to the life of these bolts. I should be somewhat afraid that after a few years this pipe, laid in a trench, would develop leaks which would be pretty hard to locate, especially with a joint every six feet. Of course they claim that if the joints are once drawn up tight and the earth thoroughly backfilled around the pipe, it is going to stay there and remain tight. I don't know how far I should want to trust that to be the case after the bolts were gone.

There is no reason, so far as I can see, why the joint should not be as tight when the pipe is new as in any pipe, and why the pipe itself should not be as durable as any pipe.

Answering Mr. Coggeshall's inquiry as to its taking the place of flexible pipe, I do not think it would take the place of a spherical jointed pipe which would be used, for instance, in laying a submerged pipe line from a scow, allowing it to sink as the pipe is jointed and thrown out. It would allow no such flexibility of joint as that,

but it does not have to be laid strictly to line and grade, as some of the ground joints of bell and spigot pipe would have to be. I would suppose that the deflection available in the pipe would be about the same as in the ordinary bell and spigot joint pipe.

THE PRESIDENT. I should like to ask Mr. Conard if he has ever had any experience with this pipe.

MR. WILLIAM R. CONARD. I have never had any direct experience with the pipe. I have seen it in one or two places, not in service, but where it has been exhibited and demonstrated for exhibition purposes more or less. I will say that it is cast horizontally rather than vertically, in 6-foot lengths. The finished portion, I think, of the male end is about an inch to an inch and a quarter in length, beveled, and the female end is not quite so long, possibly three quarters to an inch. After the bolts are drawn tight, there isn't much room for flexibility, and I should imagine when dampness got into the joint it would rust it up and make practically a solid line of pipe. What will happen after the bolts rust through, or what will happen when expansion and contraction comes on the line, is something I should judge the pipe has not been in service long enough to demonstrate fully yet. There was quite a line of it laid in Atlantic City, a year or two ago, for, I think, the Atlantic City Gas Company, all the way from 4-inch to 16-inch. I know some of it was as large as 12-inch, and I think there was some as large as 16-inch.

# SOME OBSERVATIONS ON CAST-IRON PIPE SPECIFICATIONS.

BY WILLIAM R. CONARD, BURLINGTON, N. J.

[*Read February 13, 1907.*]

It may be well for me in beginning this paper to call your attention anew to a portion of the report of the Committee on Standard Specifications for Cast-Iron Pipe, presented December 11, 1901, which is as follows:

"The committee has conceived its duty to be not the recommendation of new processes, radical changes in existing specifications, nor even an unvarying list of weights for different heads or pressures, but rather a codification of the best present practice in design and manufacture in such form that, if used as a standard, pipe can be furnished by the manufacturers, and procured by purchasers,with more certainty and satisfaction than can be done at present, even with the most perfect individual specifications, and at the same time to be sufficiently elastic to allow, with a minimum of trouble, the incorporation of special ideas in an order for pipes.

"It is believed that standard specifications, to obtain general acceptance, must allow for the personal equation of the user. While the many difficulties attending the present individualistic methods are well known, the committee recognizes the futility of the adoption of a standard which, although securing uniformity, too closely limits individual freedom of practice.

"The variation in form and dimensions of pipes and castings from different foundries, and even in different lots from the same foundry, causes much trouble and expense in pipe laying. Special castings are the most troublesome in this respect, spigots often being too large or thick to allow sufficient lead room in the bell of the pipe, even if they will enter at all without chipping the bead. Different classes of pipe often cause trouble in the same way, especially when the different thickness of shell is secured by a change in the outside diameter.

"Unless drawings are furnished for special castings (which it is not always practicable to do, especially for small orders) one does not know the length or weight, or even if the castings will

come with bell and spigot, or bells all around. Sometimes reducers are sent with bells on the large end and sometimes on the small end. The radii of bends can rarely be ascertained in advance.

" Even when drawings are furnished, unless an inspector is at the works, the castings are quite as likely to come of some other pattern and weight (not usually lighter), when the alternatives are to use those sent or wait for others to be cast and delivered.

" On the other hand, it is clearly impossible for the manufacturer to keep a stock of pipe or specials on hand, when he cannot be sure that any two orders will have the same requirements, even in the simplest detail.

" The entire lack of system in fixing the weights of pipes is the cause of much trouble and perplexity, the weight cards of the different foundries agreeing no better than the tables of different engineers. The great variety in specifications not only causes trouble in the foundry, but results to the purchaser of pipe not inspected at the works and of pipe in small lots or on quick orders, in the receipt of pipe which, although it may make fairly good work when laid, is nothing more nor less than a job lot of different sorts and sizes, very difficult to lay."

Now let us consider the circumstances which inspired this portion of and intent of the committee and report.

Just as stated, the weight cards of the foundries varied as much as the engineers' tables, and often the results obtained by the foundries themselves varied considerably from their own weight cards; and for a number of years the cry of the foundries was that the engineer's ideas as to the dimensions of the pipe for a given service and the forms, not only of his specials, but of the bells and spigots of his pipe, varied so from that of his brother engineer that the foundryman didn't know how to provide patterns, etc., to meet the demand; in other words, he didn't know " where he was at." This was, to a large extent, true, and and it is indeed gratifying to pipe purchasers generally, and must be quite satisfying to your committee, to note how generally the engineers have been willing to either wholly or in part drop their individual ideas and standards and adapt themselves to the New England Specifications.

Observations of the extent to which the various classes of pipe have been used by those taking the New England Specifications as their standard, indicate that —

On 4-in., 6-in., and 8-in., classes E and G have been most used;
10-in., 12-in., and 16-in., classes D, E, and F have been most used;
20-in. and 24-in., classes C, D, and E have been most used;
30-in. and 36-in., classes C, D, E, and F have been most used;
48-in. and 60-in., classes C, D, and E have been most used;

with a tendency toward heavier pipe — this tendency being due to the higher pressures demanded and to the increase in street traffic, both in bulk and, naturally, in weight. Where the lighter classes of pipe have been employed it has been mostly for connections in existing work, and on account of the advances in cost of pipe, where it has been necessary to get the greatest length of pipe for the least money, within reasonable safety for the use intended.

The enormous demand for cast-iron pipe, as well as other materials, during the last few years, and the consequent inability of the purchaser to get deliveries unless he were willing to take such pipe, both in dimensions and in quality, as the manufacturer would furnish, makes it difficult to arrive at a very close estimate of the proportionate quantities of pipe bought under the New England Water Works Association specifications, and under other or no specifications, but to speak roughly I estimate that about 33 per cent. of the cities of 30 000 and over in the New England and Middle Atlantic states are endeavoring to use the New England Water Works specifications; about 13 per cent. still use their own specifications; the balance I am uncertain about, but the difficulty of getting pipe during the last few years has had a somewhat deterrent effect, and probably many who would have liked to use the New England Specifications, have had to take what they could get or go without. Outside of the territory mentioned, not more than probably 15 per cent. are using New England Specifications, several still using their own, the balance accepting whatever they can get.

However, consulting and constructing engineers who have extended existing works or put in new have, almost to a man, used New England Specifications so far as the New England States are concerned.. Outside New England comparatively few have used them, although some have.

The Committee on Standard Specifications of this Association has been revived for the purpose, as I understand it, of conferring

with the committee of the American Water Works Association, and also, if found advisable, of recommending changes in the New England Specifications when experience with their use shows that a change is needed. To me it seems appropriate that we ask ourselves the question; Has not the time about arrived when we should consider the advisability of some changes in the specifications?

Experience has shown that only about four classes, and they the middle classes, have been very generally used.

While to maintain one outside diameter and vary the weights or classes by increasing or decreasing the internal diameter would theoretically be a thing that would suit nearly all parties interested, both purchaser and manufacturer, it cannot be done successfully in actual foundry practice; for while a mechanism can be laid out on paper that would do the trick to a nicety, a mechanism to vary the cores for the different classes involves the making of a machine of various and very accurate adjustments, and as the average coremaker is not an expert machinist, he would not realize the importance of having the adjustments and cores just so, while the very nature of the material used in coremaking would militate against close adjustments on such a machine; or else it involves the making of a different core board for each of the variations of a given nominal diameter and, in turn, the making of various fixtures to take the different sized cores; all of which is not only expensive to get up, but also hard to keep track of and not get them mixed, which in turn would necessitate an additional force of fixture men, and therefore an increased cost of production, and consequent increase of cost to the purchaser.

While the New England Specifications do not confine themselves to one outside diameter for all classes, they do give several classes to each specified outside diameter, which calls for the increasing or decreasing of the internal diameter; and therefore the same difficulty in manufacture is experienced as there would be in trying to use only one outside diameter.

Now, as noted earlier in this article, there have been certain classes that have been quite generally used by those purchasing under New England Specifications; would it not be possible to eliminate a number of the classes of the various sizes and so

readjust those left that the requirements for foundry fixtures will be simplified, and the manufacturer can obtain the desired weights and thicknesses with such fixtures as have been found practical?

By this I mean that by having fewer classes, and so arranging their variations that, say, four sets of cores and allied fixtures could be gotten out by the foundries to cover the pipe that would ordinarily be used, a basis would be reached that would probably be satisfactory to all. Generally speaking, the foundries have fixtures on hand that could be readily adjusted to two outside diameters, though if a reduction in number of classes was made, the specified outside diameters might need some rearranging to meet the services they would cover.

One thing the specifications are silent on is, in that portion relating to hydrostatic test, about the length of time the pressure shall remain on the pipe. Experience has shown quite conclusively that with the ordinary method of testing and the length of time which the pressure remains on, the test does not develop defects in the walls of the pipe unless they are such that the pipe bursts; for the present method is to throw the hydraulic pressure on quickly and off quickly, and the only function it performs is that of water hammer. On the smaller sizes, and the light classes of the larger sizes where the thickness of the wall is such that defects cannot hide themselves so well, this, while not desirable, in a manner answers; but on the larger sizes of the medium and heavier classes it often takes from three to five, and even ten minutes, to allow the water to force its way through any porous places, and unless there is an inspector on hand to see that the pressure is maintained for a proper length of time, it is not always done, as the facilities of the testing departments of the foundries have not been arranged to keep pace with the largely increased output. For example, there is a foundry which is turning out about 500 lengths of 4-inch to 6-inch pipe per day, with only one piece of testing apparatus to take care of this output. Their working day is about nine and one-half hours, so that it doesn't take much figuring to see that there cannot be much time spent on testing each pipe if the entire lot is to be hydraulically tested.

Therefore, it would seem as though some requirement should be inserted that the hydraulic pressure be maintained on pipe of 4-inch to 14-inch diameter say two minutes, 16-inch to 24-inch say three minutes, 30-inch to 42-inch say five minutes, and 48 inch and over ten minutes, or such time as your committee may think best.

Another matter not covered by pipe specifications, generally, is the hydrostatic testing of special castings. It has not been required largely because of the variations in forms and dimensions, but it would seem to me fully as important as the testing of straight pipe, and would develop not only weaknesses in the way of defects of the iron, but possible defects in design; and apparatus can be arranged for making these tests.

The subject is a broad one and admits of many arguments and requires careful thought. It could be extended much further, going into details of the actual use of pipe, etc., but that is out of my line and should be covered by those who are using the pipe.

## DISCUSSION.

PRESIDENT WHITNEY. The paper is now open for discussion. I think we should like to hear from Mr. McInnes, of Boston, who had great experience with pipes and castings.

MR. FRANK A. MCINNES.* I should like to ask Mr. Conard one question, and that is whether he thinks there could not be to advantage a change in our present test requirement for the strength of iron, which is that a bar 2 feet long, 2 inches wide, and 1 inch thick shall sustain a load of 1 900 pounds and shall show a deflection of not less than .3 of an inch. I recall cases where the deflection at 1 900 pounds would be about .25 or .26, and yet that iron would break up to perhaps 2 600 pounds with a total deflection of .35, entirely too hard to satisfactorily admit of drilling and cutting. It has always seemed to me it would be better to say that at 1 900 pounds the deflection shall be not less than a certain amount; in other words, is it practicable to limit the deflection at a certain loading without serious injustice to the foundry, and in that way eliminate the possibility of getting very hard iron?

* Assistant City Engineer, Boston, Mass.

MR. CONARD. I should say, yes. On a number of tests that were made some years ago for the Metropolitan Water and Sewerage Board, a series extending over a matter of possibly ten months or a year, my recollection of the deflections is that at 1 900 pounds the deflection was about .24, .25, or .26 inch, with a further deflection at 2 100 pounds of about 4 or 5 points further, and the deflection advanced with the strength of the iron in just about that ratio, about .05 of an inch for every 200 pounds of pressure brought to bear on the bar from 1 700 pounds up. Below that I have taken no records.

THE PRESIDENT. I wonder if Mr. Foss could give us any points in regard to the tests of metal referred to by Mr. Conard?

MR. WILLIAM E. FOSS.* I am not familiar with the results of those tests, so cannot state intelligently anything about them.

THE PRESIDENT. How much experience have you had with these standard pipe specifications, Mr. Foss?

MR. FOSS. Very little. Most of our pipe laying was completed before the standard specifications were adopted, but during several years on this work I had considerable experience in laying pipes cast under the Metropolitan Water Works specifications then in force. There are two points that I had thought of on which I should like to hear from Mr. Conard. He has already mentioned one of them, that is the testing of special castings. It always seemed to me that it was much more important to test the special castings than it was to test the straight pipes, but I had not understood before just why the specials were not tested. The other point I should like to ask about is in regard to the special curves for 48-inch and 60-inch pipe lines. I have found in laying pipe lines with these curves of large diameter that the curves throw an angle less than is specified. It is always that way; the deflection obtained is less than the specified angle of the curve used. I suppose there is a reason for it, and perhaps Mr. Conard can tell us what it is.

MR. CONARD. I don't know as I quite understand just what you mean. You mean there is a difference that does not show in the design of the special between the short side and the long side of the curve?

* Division Engineer, Metropolitan Water Works, Boston, Mass.

MR. FOSS. Yes. For instance, a 45-degree curve, instead of throwing 45 degrees, will throw about 44 or 44½ degrees; and a $\frac{1}{16}$ curve will throw 22 degrees or perhaps as low as 21 degrees, or even less, instead of the specified 22 degrees 30 minutes.

MR. CONARD. Don't you find it works the other way too, at times?

MR. FOSS. No. All my experience has been that the special throws less than the specified angle.

MR. CONARD. My experience with specials is that the length will vary somewhat. Testing them with a templet I find variations; some of them come short, some of them come longer than called for, and the only solution I could ever get of it is that it is due to shrinkage, that there will be variations in the shrinkage of the iron. I have also found that where a casting was carefully built up, the mold built just to length, making allowance for this shrinkage, on the short side it might come less than the requirement and on the long side be long, therefore throwing the angle out somewhat. Then I have found it where both sides would be long, and I have also found it where the shortest side was a bit long and the long side a little short. The only reason I could ever give for that was the shrinkage was not always quite equal in the cooling of the casting. If you will just remind me what your first question was, I should like to answer that.

MR. FOSS. That one regarding testing of specials; I think you did answer in a measure in your paper.

MR. CONARD. It would seem very important that specials should be tested. One reason why it has not been done is because of the difficulty of getting up apparatus which would do the work satisfactorily at the foundry. That, I guess, is the real reason why it has not been done heretofore. But it would seem to be a good thing, and a very important thing. I have in mind a 48- by 36-inch tee, which I was looking at some years ago, which was defective, as I claimed. The foundry took exception to the matter and it was carried along for some time. Finally the casting was shipped to the point of destination and I was afterward called over, before the casting was used, and after a conference the casting was broken and it was very clearly demonstrated that the

casting was not only defective, but very defective. If an arrangement could have been made to have subjected that casting to a pressure test at the foundry it would have very clearly demonstrated there and then that it was a defective casting, and it would have saved a lot of worry and trouble.

MR. FOSS. There is one other point which possibly Mr. Conard can give us some information on, and that is the coating of pipes on the outside. I don't know what the foundry practice is, but I imagine from what I have seen of pipes that have been exposed to gases and electrolysis that after the pipe is coated it must be rolled out on skids while still damp, before the coating has thoroughly hardened; as I find that rusting and disintegration of the iron take place in rings about 2½ feet from the bell and spigot ends. It would be very desirable to have that avoided.

MR. CONARD. That is another case where the foundries have not quite kept up with their output in handling the pipes for coating. The output at the present time of the pipe foundries is such that it would simply be impossible for them to take a pipe and coat it and lay it in a position where it might remain inert until the coating had hardened so that there would be no breaking of the surface after it was cooled. It is true that as a rule they are placed on skids and turned over, or partially turned over every few minutes until they reach the point of weighing and testing. That is done for two reasons. One reason is to allow the flow of the coating to become equal all over the pipe, as the pipe and coating are both hot when the pipes are dipped, and naturally the coating stays somewhat fluid until cool; and the other, of course, is to make room for pipe which are being coated afterwards.

MR. JOHN DOYLE.* I think I can agree with what the gentleman on my left [Mr. Foss] says with regard to the variation of specials. My experience has been in laying 40-inch pipe and 30-inch pipe on a 50-foot radius, the trench having been laid out by a competent engineer, that I could not make both ends meet, and it has been necessary for me to make the trench fit the pipe. I have found quite a difference between the long end and the short end of the curved pieces, and I have found that in a great many instances.

* Boston Water Works, Boston, Mass.

MR. FRANK L. FULLER.* I think this testing of special castings is a very important matter, and am glad it has been brought up. In a water works job this last season, with 7 or 8 miles of pipe, there were at least 4 specials that proved defective. I don't know how many others there were, because, in many cases, we had to do the back-filling before the pipes were tested. In one case, where it was necessary to cross a river on a special bridge, two out of four $\frac{1}{8}$ bends, which had come late in the season and which we needed at once, were defective, and we were obliged to wait three or four weeks to get new ones; and one of these was defective. We calked it up the best we could and let it go. I suggested to the foundry that it would be a good thing to test their specials, but they said they made so many they could not do it. It seemed to me that the more they made the more necessity there was of testing them.

Now it is very annoying to get a line of pipe laid and turn on the water and find that some of the specials leak. It means a long delay in getting new ones. If you have a leaky straight pipe you generally have pipe enough on hand to replace it and you get over your difficulty at once; but if you have a leaky special and have to wait three or four weeks to get a new one, it is a serious affair. I think the towns and cities would be willing to pay enough more for their specials to have them tested, and I think it would be a great satisfaction to know that the castings we are using had actually been tested and were perfect.

MR. CONARD. The question has been asked, Why cannot the hydraulic test be made on specials handily by using a ball or knuckle joint on the angle end of a special? There could be apparatus arranged for testing specials, but it would be quite expensive, though I saw a wrinkle only a few weeks ago at the Pennsylvania Steel Casting Company's works at Chester, Pa., which appealed to me quite strongly for the testing of special castings. The folks there had arranged a large circular frame with four moving heads operated by hydraulic power, and by that method they were able to clasp almost anything, of almost any shape, and subject it to hydraulic pressure. It seemed to me if this question of testing specials were only taken up and

* Civil Engineer, Boston, Mass.

insisted on (made a portion of the specifications), the manufacturer would be willing to put in some such apparatus, and I think that an apparatus of that character could be made to work quite satisfactorily.

THE PRESIDENT. I think we should hear something from the foundrymen's end of this subject, and I will call on Mr. Walter Wood for a few remarks.

MR. WALTER WOOD.* It was exceedingly interesting to me to hear the opening suggestions of the paper about what we used to run up against in the olden times. Every engineer used to send in a different pattern, not only for the internal diameter of his pipe, but also patterns for an infinite variety of special castings. I am glad that this old history has been touched on, because it is a source of great annoyance as the pipes are being laid, and it is often and naturally thrown up at the manufacturer that he was making things of every kind, when as matter of fact he was compelled to do so on account of the variety of orders which came in and to which he had to adapt himself.

It is fortunate, however, that the discussion about standards has gone so far that a large part of that irregularity has been eliminated from the burdens that have been thrown upon the foundryman. He is only too ready to adjust himself to any lines that can be worked on regularly, and it will be a comfort to him, and a great comfort to the people in the pipe trench, if steps in that direction are well taken, and they will always have the foundryman's strong and active support. It will take a little while to thresh the matter out. Our pattern loft is filled with all sorts of designs, and some people will still have specials or goods made from those designs. But time will settle all that, and when we get the subject of standard specifications finally worked out the trouble will be a thing of history.

There is one thing that I am sorry occurred about forty years ago. It is well known in New England in connection with the Salem water works. Perhaps none of us are quite old enough to recollect all the occurrence, but it has gone into history, and we are more or less familiar with it.

I refer to it merely to lead up to this one fact, that so far as I

* Of R. D. Wood & Co., Philadelphia, Pa.

have any knowledge of cast-iron pipe foundries, there is absolutely no attempt on their part to do otherwise than to follow the wishes of their customers. I think they all wish to do thoroughly good work, and all wish to fall in with ideas that are put before them, although sometimes making practical suggestions regarding them; but there is no thought on the part of any of the founders whom I know of any antagonism or difference of interest — that is the best word to use — between the persons who buy and the persons who make. Our interests are all one, and I think anything which is taken hold of by the users of pipe which will benefit the manufacture and the furnishing of it, will be met with that spirit on the part of the manufacturers.

The specifications which were originally adopted by the New England Water Works Association, and which were so widely spread and so widely used, have naturally come under more or less discussion, and particularly on one point, which was alluded to in the paper just read and I think very properly so; that is, the large number of classes in the specifications. The discussion which has taken place on the subject of classes has largely brought itself down to this: If you will take the two extremes of weight which are generally used in pipes, you will find that about four classes will cover this range of weights, so that each class will not be more than the allowed variation from the other. Of course I am speaking approximately. In other words, there is an allowance of 8 per cent., four up and four down, and there are four classes, and that is 32 per cent. That will largely cover all the variation of weights between the high weights and the low weights, and, therefore, a more careful investigation of the subject of classes has led those who have followed the New England movement to come to four classes.

The gentleman who read the paper very properly alluded to the question of the making of cores, and whether the variation of weights could be made through the variation of the cores or through the variation of outside diameters. If that question is carefully looked into with the drawings before you, you will find that four classes can be reached with the use of two patterns of outside diameter, and one variation of the core for each; this will make the four classes. You will, therefore, only have one variation

of outside diameter and one variation of core, which will simplify the question very much with the manufacturers; and while it is not exactly the best theoretical way of meeting the question, yet it is probably the best solution between practice and theory. In this way the matter of classification readily adjusts itself.

There was a suggestion in the paper that the manufacturers had a specification of their own. Perhaps in ordinary parlance there is some basis for alluding to it in that way. But, to put it a little more accurately, it is this way: The American Society for Testing Materials appointed a committee which, in considering the specifications, worked out the four classes I have alluded to, and also made some other changes, not very prominent ones, in the New England specifications. That society's specifications have now been before the country for some little time, and perhaps have been more used by the foundrymen in their own practice than the New England specifications, and hence they may have come to be called the foundrymen's specifications. But they are *not* the foundrymen's specifications; the fact is merely that when two specifications are laid before the foundryman he naturally chooses that which is the simplest, easiest, and cheapest to manufacture under. There is really very little difference between the two, and it is chiefly in the subject of classification which we have been speaking about.

It would be very well if specifications could be uniform not only in this country, but, for those of us who are on the seaboard, in foreign countries also. It is a matter of some pride with us in America to have foreign trade, and uniform specifications would very largely help. So perhaps that has been a factor in the foundryman's thoughts in working under the Society for Testing Materials' specifications, viz., the idea of working towards an international standard.

I only speak of this question of the foundrymen's specifications because I want to get it clearly before our friend's mind that there is no antagonism to the specifications adopted by the New England engineers.

There is one other thing in connection with international specifications which will naturally come up, and it is a very excellent one for the buyer to think seriously about. It is im-

possible to make a casting 13½ feet long without the upper end being more or less porous. Abroad their custom is to cut off that end for 3 or 4 or 5 inches, and in that way they get a much more perfect pipe than is called for by our American specifications. In our large-diameter pipes we have in our foundry adopted the principle very largely, though not in every case, of cutting off the ends of the pipe so as to secure a clean spigot. As it is an added expense, we haven't done it in every case, but the tendency of our manufacture is towards cutting off the upper end of every pipe in order to get a perfect spigot, which is a very desirable thing, because the bead is the weakest part of the pipe, and it is a constant trouble to the inspectors to know whether they should pass a pipe with 1 hole or 3 holes or a dozen holes in the spigot, and it is a constant source of worry and loss to the consumer and to the manufacturer until the point is settled. Had we better not adopt in this country the principle of cutting off that portion of the pipe which is always more or less porous and always giving trouble to everybody and is a source of constant friction? I suppose if we ever reach an international specification that will be one clause which every foreign engineer will insist shall be inserted, viz., to make a pipe perfect by cutting off the part of the pipe which is always more or less bad. Whether or not the time has come for doing that in this country is for the persons who buy pipe to settle. It will not add very much to the expense, and will certainly give them what we all aim for, that is, more perfect castings.

There is another matter which I may speak of as a matter of curiosity, although I think both the English engineers and the American engineers will be slow to adopt it. The best foreign practice is to have no bead on the end of the pipe. I think there is too much conservatism among our engineers, however, to do away with the bead offhand, and I only speak of it as an advance in the manufacture of pipe which has been largely adopted abroad, but which I am afraid our conservatism will keep us from promptly adopting here.

The function of the bead after all is not to strengthen the end of the pipe, because the slight ring of cast iron which constitutes the bead is too small a piece of metal to strengthen materially the end of the pipe. A 6-inch pipe weighs over 300 pounds, and a

12-inch pipe weighs 1 000 pounds, and no little ring of iron like a bead will furnish strength to stand the dropping of the pipe on its end. The bead adds so little strength to the end of the pipe that I don't know why it was put there originally, unless it was for the sake of helping to center the pipe as it goes in the socket, so the man in calking won't have the barrel of the pipe lying on the bottom of the socket. That is to my mind the real function of the bead, — that it tends to help the calking.

Now the way that is secured in the pipe that has no bead is to have a slight taper at the bottom of the socket, so that when the pipe is driven home the end of the pipe centers itself on the taper, and the full calking room is at once obtained, instead of the calking room which the bead gives, which is only the height of the bead and which is not the full calking room. So really a beadless pipe centers rather more accurately and rather more thoroughly than a pipe with a bead.

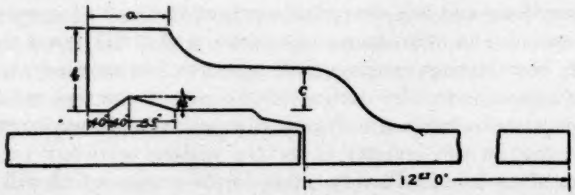


FIG. 1. JOINT IN CAST-IRON PIPE WITHOUT BEAD ON SPIGOT END.

The question of time in testing is an exceedingly interesting one. Perhaps I can illustrate it by speaking of the discussion which occurred in the American Society for Testing Materials as regards test-bars. The committee having that detail in charge brought the question before the Society, and one of the professors of a technical institution of Boston spoke on the question of the time of the test-bars in the test as influencing the ultimate breaking strength. Later he made some tests at our factory, and the result was that the element of time in testing test-bars was eliminated from the report. The time of the test has a certain influence, but not such a commanding influence as to make it a question to dwell on or an important point.

A pipe in a foundry is generally from one to two minutes in going through the press. As I have stood at the testing press where we test our 4- and 6-inch pipe, it is about a minute from the time it goes in to the time it comes out. The pressure has been on it even less than a whole minute, because part of the minute is taken up in the handling. In the case of larger pipe, of course the time has to be longer on account of the physical requirements in handling the machinery and the castings. We had one large contract for 60-inch pipe where the specification required that the test be kept on ten minutes, which, so far as I have learned from our foundry superintendents, developed nothing of value in the time of testing. Yet it is a question which I do not want to be settled offhand, and I should be glad to have you look into it, because anything which advances the manufacture is a thing to be adopted. I am only speaking of it as what we have learned from experience, that a long time in testing does not develop more strains than a short time in testing.

The allusion that has been made to the variation of angle of bends varying between 43, 44, and 45 degrees is one which I think was fairly explained; that is, the contraction of iron from a molten to a solid state is an uncertain question. The length of a straight pipe will vary from $\frac{1}{2}$ to $\frac{3}{4}$ inch simply from the contraction. That same thing happens in your curves, and on one side it will sometimes happen to be more than on the other. It is a thing which cannot well be avoided in manufacture. But unless the difference of curvature amounts to more than 4 or 5 degrees it becomes an insignificant quantity, because 4 or 5 degrees can be easily taken up in the adjustment of the spigots in the sockets.

The rings which Mr. Foss spoke about as being on the pipes after they are coated are something which is very annoying to the manufacturer. He doesn't like it, but what is he to do with a pipe after it comes out of the bath? He can't hold every pipe upon chains until it drains; he has got to lay them down. It would be unwise for buyers of pipe to ask for machinery to be made for suspending all pipe until cool, because it would add so much to the cost of the pipe that the game would not be worth the candle. Pipe has to be laid down and it has to be rolled to get it out of the way, and hence there will be rings.

I don't see how they can be avoided unless buyers of pipe wish to pay for placing the pipe on end, standing them around under cranes until they are cooled. Of course anything that the buyers of pipe want, the manufacturers will be ready to furnish and to accede to if it is understood in advance. The expense will be simply a question of so much per ton. But I really don't see any practical way of overcoming that matter of rings on the pipe. The pipe has to be laid down and rolled out of the way, unless there is some very elaborate arrangement for standing them on end.

The more important question, however, is the testing of specials. It is a very unsatisfactory thing on both sides. The question of testing pipe is a very simple thing, because after all a pipe is only a column, and to close one end you use a movable head and gasket which forces the pipe up against a stationary head with its gasket. The pipe is then subjected to a direct transmission of strains which cast-iron pipe is very well able to stand. Now when you undertake to test a cross or a tee you not only have to close the ends, but you have to close the arms. In closing those arms, especially in a large casting, sufficiently tightly to stand the pressure, you put new strains upon your castings, and strains which never occur in practice. So that, if castings are to be tested, it will involve a redesigning and using quite a quantity of extra metal. Now I am not giving this as an argument against testing specials, because, as I have said before, anything that the users of pipe want and will pay for they should have. But one of the things in connection with testing specials that must be borne in mind is that they will not only have to be tested for their work in the ground, but they will have to be designed to stand the unusual strain which the testing itself throws upon them.

I take it the reason that there has been no more trouble from the non-testing of specials than has been the case is because there is an extra amount of metal in the special, not for the sake of the foundryman getting an extra price, but because the cutting of a hole in the side of the pipe requires the replacement of an equal and more than equal amount of metal around the hole so that the casting will not break. To illustrate what I mean, we had a request at one time to test a lot of manhole branches. The long diameter of the manhole was parallel with the barrel of the pipe,

and we broke them right straight along. I suggested, Why not make the long diameter of manhole at right angles to the axis of the pipe? And instead of cutting a hole 18 inches in the side of the pipe, it was only 12 inches, and the casting stood. I only speak of that to show how you have got to replace the metal which you cut out of the side of the pipe for the opening, and more than replace it, because you don't put it where the strain really comes, but you put it at the side of the opening.

Now the question of testing, when it is practically and carefully worked out, comes down to the cost of testing and the cost of the additional metal which you put into the casting for safety. I should say it would be cheaper, speaking offhand, to furnish extra metal than to pay the expense of testing a special. If the buyers want them tested we will test them, but those two points had best be thought of, whether the cost of testing had not better be put into an extra weight of iron, and also the question of redesigning specials to stand the test strains.

MR. CONARD. Mr. President, in speaking of the pipe manufacturers having adopted a standard other than the New England specifications, I did not wish it to be inferred at all that I thought there was any antagonism on the part of the manufacturer as between what he thought should be the specifications and the specifications which had been adopted by the New England Water Works Association. I merely spoke of it to illustrate the fact, just as Mr. Wood said, that it was getting down to the basis of the best thing between theory and actual practice.

A little further on the question of the variation of the internal and external diameters: In making pipe designs you get a center for your core, and if the requirements as to variation of diameters between the largest and smallest diameter for a given nominal diameter are too great it will necessitate the making of a considerable quantity of additional fixtures, — socket irons, cups, centers, etc., and if the variation was very large possibly new core bars in order to take care of the amount of stock, as it is called in the foundry, which would work well. All of that would entail the making of a great many and various fixtures in order to make pipe of a given nominal diameter; and that is one of the reasons why, if the purchaser of pipe can reach the point where he feels

that he can possibly reduce the number of classes which he wishes to use, it will reduce the quantity of fixtures that would be necessary to get up for producing a given quantity of pipe, and that would tend to keep the cost of pipe within what the purchaser considers reasonable limits.

MR. FOSS. Mr. President, I should like to say a few words about curves being not as they are designed. That is a point I referred to, because the variation is always in one direction,— the deflection angle is always small. I measured fifteen or twenty 48-inch curves carefully after I had some trouble with them, and found the deflection angles were all smaller than specified. It becomes a matter of considerable importance on large pipe. On small pipe, 6, 8, 10, or 12 inches, it doesn't matter, but with a 48-inch or 60-inch pipe it does. The most you can deflect a 48-inch pipe by opening the joint is about one degree in good practice. If you have a corner where you want to use four $\frac{1}{16}$ curves to make a quarter turn, and each of them is out about 2 or $2\frac{1}{2}$ degrees, you need another special to make the turn, because you cannot do it by opening the joints. As the deflection angle is always too small, it seems to me some allowance might be made so that the curves will average about what they are designed for, if the error is due to shrinkage.

In regard to the bead on the pipe, I think there is a point in connection with the practical use of it which has been overlooked. I do not think it is of value so much for strength as for use in laying. It is a stop for the yarn, and is of use in raising the pipe when spacing it evenly in the socket. The method suggested of having a tapering socket to center the pipe in would not amount to very much in practice, because there is not one time in fifty that a pipe line is exactly straight. You are either laying it around a curve or over a hill, or something of that kind, so that you are deflecting from a straight line or grade all the time, and the spigots would not be centered in the sockets.

MR. WOOD. Mr. President, if it is a fact about the curve straightening itself out under contraction, — which I would be very glad to look into, because it is an interesting thing and something I never have had called to my attention, — it is a simple matter for the engineers to instruct their inspectors to have a

larger angle provided in the mold, so that the pipe will be eventually, when cooled, exactly the angle wanted. But in saying that I want to leave this thought, that the amount of contraction in cooling is a thing which I am afraid Nature takes care of very much more than mankind, and we will never be able to absolutely control it. We see that constantly in making flanged pipe, where we are expected to make them to an exact finished length and we never can do it without facing off the back of the flange and making the flange materially thicker in order to give metal to take the come and go of the contraction.

As to the matter of the bead, I think I made it clear that the conservatism in this country and in England will hardly permit its being taken off. As to its working in actual practice, there is no question whatsoever. It is discarded on so many thousand tons of pipe that its working in actual practice is a settled question, and it is settled to such an extent as this, if you will pardon me for a moment in explaining. We took quite a large contract for Java. The Dutch government felt uncertain as to the ability of Americans to make cast-iron pipe, and they sent their engineers over here to see whether it was possible for us to do it. I at once objected to their having no bead on their pipe. The engineers said they would put on their hats and go home, that they knew enough about the subject to know what they were talking about, and that this pipe was to have no bead or there was to be no contract. That is the way the people look at it who have worked it out in practice. You can make a good many objections to almost anything that is new, and yet in practice it has worked and does work satisfactorily.

# PROCEEDINGS.

## December Meeting.

Hotel Brunswick,
Boston, December 12, 1906.

William T. Sedgwick, President, in the chair.
The following members and guests were present:

### Honorary Member.

Wm. T. Sedgwick. — 1.

### Members.

C. H. Baldwin, L. M. Bancroft, F. A. Barbour, W. T. Barnes, J. W. Blackmer, George Bowers, G. A. P. Bucknam, F. H. Carter, J. C. Chase, J. W. Crawford, A. W. Cuddeback, A. W. Dean, H. P. Eddy, F. F. Forbes, W. E. Foss, F. L. Fuller, J. A. Gould, F. E. Hall, J. O. Hall, L. M. Hastings, T. G. Hazard, Jr., D. A. Heffernan, H. G. Holden, J. L. Howard, W. S. Johnson, E. W. Kent, Willard Kent, G. A. King, L. P. Kinnicutt, C. F. Knowlton, E. S. Larned, Thomas McKenzie, H. V. Macksey, N. A. McMillen, D. A. Makepeace, A. D. Marble, W. P. Mason, F. E. Merrill, Leonard Metcalf, F. L. Northrop, O. E. Parks, E. M. Peck, G. H. Palmer, E. B. Phelps, T. A. Peirce, Ransome Rowe, W. W. Robertson, H. W. Sanderson, E. M. Shedd, C. W. Sherman, G. H. Snell, W. F. Sullivan, R. J. Thomas, W. H. Thomas, L. D. Thorpe, D. N. Tower, W. H. Vaughn, F. B. Wilkins, G. E. Winslow. — 59.

### Associates.

Builders Iron Foundry, by A. B. Coulters and F. N. Connet; Chapman Valve Manufacturing Company, by Edw. F. Hughes; Hersey Manufacturing Company, by Albert S. Glover, H. V. Macksey, and W. A. Hersey; International Steam Pump Company, by Samuel Harrison; Lead Lined Iron Pipe Company, by Thomas E. Dwyer; Ludlow Valve Manufacturing Company, by H. F. Gould; H. Mueller Manufacturing Company, by George A. Caldwell; National Meter Company, by C. H. Baldwin and J. G. Lufkin; Neptune Meter Company, by H. H. Kinsey; Rensselaer Manufacturing Company, by F. S. Bates and C. L. Brown; Thomson Meter Company, by E. M. Shedd; Union Water Meter Company, by F. L. Northrop and C. E. Merrill; R. D. Wood & Co., by W. F. Woodburn; Water Works Equipment Company, by W. H. Van Winkle. — 20.

GUESTS.

E. L. Field, chairman Water Board, Northfield, Vt.; J. H. Hill, commissioner, Lowell, Mass.; H. E. Cowan, I. N. Scribner, L. Vredenburgh, Boston, Mass.; A. E. Blackmer, superintendent Water Works, Plymouth, Mass.; C. W. Gilbert, Woburn, Mass.; C. H. Pierce, Springvale, Mass.; F. A. Collins, Philadelphia, Pa. — 9.

[Names counted twice. — 5.]

The Secretary read the following names of applicants for active membership, all of whom had been approved and recommended by the Executive Committee:

*Non-Resident.* — John Herbert McManus, West Hurley, N. Y., assistant engineer, Water Department, New York City; Perkins Boynton, Little Falls, N. J., bacteriologist and chemist, East Jersey Water Company, Little Falls, N. J.; Burton G. Philbrick, Brooklyn, N. Y., water sanitarian, Lederle Laboratories, New York; August E. Hansen, New York City, sanitary engineer with Williams, Proctor & Potts, New York City; Selskar M. Gunn, Iowa City, Iowa, assistant bacteriologist, State Board of Health, Iowa; Luther R. Sawin, Mt. Kisco, N. Y., chemist and bacteriologist, New York Water Department; Louis J. Richards, Elizabeth, N. J., health officer, Board of Health, Elizabeth, N. J.; W. F. Currier, Philadelphia, Pa., chemist and bacteriologist with Booth, Garrett & Blair, Philadelphia, Pa.; William J. Roberts, Pullman, Wash., professor of civil engineering, State Agricultural College, and consulting engineer, State Board of Health of Washington; Henry A. Pressey, Washington, D. C., designer and constructor of water works and sewerage systems; Arthur B. Cleaveland, Orman, S. D., United States Reclamation Service; E. F. Kitson, Norfolk, Va., supervising engineer for Southern Construction Company, etc.; John W. Maxcy, Houston, Tex., designer and constructor of water works and purification of public water supplies; Alex. J. Taylor, Wilmington, Del., engineer Sewer Department, Wilmington, Del.; L. R. Thurlow, health officer, Plainfield, N. J.; Charles F. Breitzke, White Plains, N. J., with John M. Farley, civil engineer, and in charge of construction of reservoir at Mt. Kisco, N. Y.; William H. Beers, Jr., chemist and bacteriologist, Water Department, Columbia, N. C.

*Resident.* — Nathaniel W. Hayden, Windsor, Conn., president and manager Windsor Water Company; Albert L. Sawyer, Haverhill, Mass., registrar Haverhill Water Works; Jas. A. Newlands, Middletown, Conn., assistant chemist and bacteriologist, Connecticut State Board of Health; William L. Butcher, Boston, Mass., assistant in office of chief engineer, Massachusetts State Board of Health; Herbert C. Emerson, M.D., director Emerson

Laboratory and member of Board of Health, Springfield, Mass.; Frederick W. Farrell, Springfield, Mass., chemist and bacteriologist, Emerson Laboratory, Springfield, Mass.

On motion of Mr. Fuller the Secretary was requested to cast one ballot in favor of the gentlemen whose names had been read, and he having done so they were declared duly elected members of the Association.

PRESIDENT SEDGWICK. There is one matter which the Executive Committee has instructed me to bring before the meeting, and that is a vote of theirs, as follows:

" In view of the immense economic importance to the people of New England of the careful preservation of their forests, for the safeguarding of their water supplies and water powers, it is recommended that the following resolution be passed by the Association:

" That the President and Secretary be authorized and instructed to address an appeal on behalf of this Association to the members of the House of Representatives from New England urging each Representative to petition the Speaker without delay that the bill now pending, known as House Bill No. 13, which provides for the establishment of the Southern Appalachian and White Mountain forest reserves, be taken up for final action at an early day in the present session."

With reference to this action of your Executive Committee, I should like to say one word. The bill described here has been pending for some time in the National Congress. It has been passed by the Senate, it is strongly favored by the President, but we are told that it is being " held up " by the Speaker, who declines to allow it early consideration in the House. Those who are interested in this bill, and they are a very large number of the inhabitants of New England and of the eastern United States, — for this covers the Southern Appalachian as well as our own mountain region, — desire to get their members in Congress to bring it forward as quickly as possible. Moreover, while a resolution like this passed by the Association to-day will be of value, the most valuable thing which can be done, and the most helpful, will be for every one of us to write a letter to his Representative — not to his Senators, but to his Representative in

Congress — or to see him, personally, and urge him to advance so far as he can the interests of this bill.

This Association does not go into politics, but your Executive Committee does not think that this is politics. This is literally self-preservation. If the White Mountain region is to be denuded the damage to our New England water powers will be very great. Here is a bill, the passage of which is desired by a very large proportion of our people, and which we, as an association of water works men, feel deeply interested in. I would, therefore, respectfully urge you to get into touch, if you can, with your own Representatives from Massachusetts, Connecticut, Rhode Island, New Hampshire, Vermont, and Maine, and ask them to push this thing forward as fast as they can. The resolution is a formal one, and you can quote it to your Representative if you like. It comes before you with the recommendation of your Executive Committee that it be passed. What is your pleasure with regard to it?

On motion of John O. Hall it was unanimously voted that the resolution be accepted and adopted.

The first paper of the afternoon was by Mr. E. S. Larned, of Boston, Mass., and was entitled "Use and Tests of Cement and Concrete." Mr. Frank L. Fuller and Prof. William P. Mason took part in the discussion. The second paper was on "The Explosion of the Saratoga Septic Tank," by Dr. William P. Mason, professor of chemistry Rensselaer Polytechnic Institute, Troy, N. Y. This paper was discussed by Prof. L. P. Kinnicutt, Mr. Harrison P. Eddy, Mr. John A. Gould, Mr. Frank A. Barbour, Mr. Earle B. Phelps, and the President.

Adjourned.

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## Annual Meeting.

Hotel Brunswick,
Boston, January 9, 1907.

The President, Prof. William T. Sedgwick, in the chair.

The following members and guests were present:

### Honorary Member.

Wm. T. Sedgwick. — 1.

MEMBERS.

S. A. Agnew, M. N. Baker, C. H. Baldwin, L. M. Bancroft, G. W. Batchelder, C. A. Bogardus, J. W. Blackmer, George Bowers, E. C. Brooks, G. A. P. Bucknam, James Burnie, C. E. Childs, J. C. Chase, R. C. P. Coggeshall, M. F. Collins, W. R. Conard, A. O. Doane, J. N. Ferguson, A. D. Flinn, J. H. Flynn, G. H. Finneran, F. F. Forbes, W. E. Foss, A. D. Fuller, F. L. Fuller, W. B. Fuller, J. C. Gilbert, D. H. Gilderson, A. N. French, A. S. Glover, J. O. Hall, J. C. Hammond, Jr., V. C. Hastings, D. A. Heffernan, H. G. Holden, W. S. Johnson, E. W. Kent, Willard Kent, Patrick Kieran, G. A. King, C. F. Knowlton, S. H. McKenzie, Hugh McLean, N. A. McMillen, A. E. Martin, W. E. Maybury, John Mayo, F. E. Merrill, Leonard Metcalf, H. A. Miller, F. L. Northrop, E. M. Peck, Wm. Naylor, J. H. Perkins, E. M. Shedd, C. W. Sherman, Sidney Smith, G. H. Snell, G. A. Stacy, W. F. Sullivan, H. A. Symonds, J. A. Tilden, R. J. Thomas, W. H. Thomas, J. L. Tighe, D. N. Tower, G. W. Travis, W. H. Vaughn, C. A. Townsend, C. K. Walker, J. C. Whitney, G. E. Wilde, F. B. Wilkins, G. E. Winslow. — 74.

ASSOCIATES.

Harold L. Bond & Co., by Harold L. Bond; Chapman Valve Manufacturing Company, by Edw. F. Hughes; Coffin Valve Company, by F. E. Adams; William H. Gallison Company, by H. E. Stilphen; Hersey Manufacturing Company, by Albert S. Glover, J. A. Tilden, W. A. Hersey, A. H. McAlpine; International Steam Pump Company, by Sam'l Harrison; Jenkins Bros., by J. D. Stiles; The Fairbanks Company, by F. A. Leavitt; Lead Lined Iron Pipe Company, by T. E. Dwyer; Ludlow Valve Manufacturing Company, by H. F. Gould; National Meter Company, by C. H. Baldwin, J. G. Lufkin; Neptune Meter Company, by H. H. Kinsey; Rensselaer Manufacturing Company, by C. L. Brown; Platt Iron Works Company, by F. H. Hayes; A. P. Smith Manufacturing Company, by F. N. Whitcomb; Thomson Meter Company, by E. M. Shedd; Union Water Meter Company, by F. L. Northrop; United States Cast Iron Pipe & Foundry Company, by F. W. Nevins; R. D. Wood & Co., by W. F. Woodburn; Water Works Equipment Company, by W. H. Van Winkle. — 24.

GUESTS.

F. L. Weaver, A. Weaver, E. B. Carney, C. A. Nelson, Lowell, Mass.; E. T. Harvell, Rockland, Mass.; F. L. Clapp, superintendent Water Works, Stoughton, Mass.; Clifford Baylies, water registrar, New Bedford, Mass.; Edwin Leavitt, Somerville, Mass.; N. P. Potter, Braintree, Mass.; Samuel W. Hoyt, Jr., South Norwalk, Conn.; A. E. Blackmer, Plymouth, Mass.; George F. Whitney, Natick, Mass.; John J. Nugent, water commissioner, and Frank Woodbury, 2d, chairman Water Board, Beverly, Mass.; Frank Smith, Kineo, Me.; Charles H. Rollins, commissioner, Watertown, Mass.; H. E. Cowan, Boston, Mass. — 17.

[Names counted twice. — 5.]

After dinner had been served President Sedgwick called the meeting to order and spoke as follows:

## President's Address.

*Gentlemen of the Association,* — A wise custom makes it incumbent upon the retiring officers of your Association to give at the annual meeting some account of their stewardship. In conformity with this custom I propose in a few words to call your attention to the principal events of the year that has gone, to touch upon the present and prospective condition of the Association, and then to make way for those who are nearer the field of action — the Secretary, the Editor, the Treasurer — than is your President.

Associations like ours date back, as you may be interested to know, for about three hundred years. Almost exactly three hundred years ago a little band of scientific students — we can hardly call them scientific men — in Rome, got together, in the absence of any prevailing popular scientific enthusiasm, in the absence of events of stirring scientific interest, such as surround us to-day, but yet filled with the love of knowledge, and with an enthusiasm for Nature and for the study of Nature, and formed a body which they called the Society of the Lynx, that is to say, of the keen-eyed. That society, which is known as the *Accademia dei Lincei*, was the first in a long series of scientific societies and technical organizations like our own from that day to this. It still exists in Italy and is the leading scientific organization of that now strong, active, and enterprising country. It was followed by the organization of the Royal Society of London, that by the French Academy of Paris, and that by a similar society in Germany; and from that day to this earnest and thoughtful and enthusiastic students of Nature and the Arts have gathered themselves together, as we have done in this Association, for mutual benefit and for the study of the things that interest us in this world.

The year that is gone has shown no great change in the characteristics of our Association. It still remains an organization for mutual benefit, and it still has the same objects in view which it has had from the beginning. Some of those I may touch upon in a moment. But first let me say that we are rapidly becoming

a body of more than local importance. Our numbers are drawing near the 700 line. They have increased this year from 645 in all to 684 in all. Our Associates have fallen in number from 53 to 51; our Honorary Members have increased from 8 to 15, and one of our Honorary Members, Mr. Croes, a justly famous engineer, has died. The decrease in our Associate membership is, doubtless, due in large measure to the tendency of the times to combine, and thus diminish the number of industrial and similar organizations. The growth in our active resident and non-resident membership seems to me strong testi mony to the usefulness of the Association for never before has there been a time when men have been invited to join so many organizations or pay so many fees as to-day. When, therefore, we find 600 men and more continuously connected with the New England Water Works Association and paying their fees with regularity and promptness we cannot help but feel that they get something out of the Association; in other words, that they find it useful.

Before leaving the subject of membership, upon which I do not care greatly to dwell, I do wish to say one word about our Honorary Members. It has seemed to me for some time, in fact ever since I was myself elected an Honorary Member, — thanks to your courtesy and consideration, — that our list of Honorary Members was not yet such as was worthy of the Association; I mean that it did not contain many of those distinguished names which might well be upon our rolls with honor to the Association and with honor to themselves. I was, therefore, very glad when the Executive Committee at the Annual Convention proposed, and when the Association elected, a number of the most distinguished men in the United States more or less closely connected with water works, to honorary membership in this Association. It became my pleasant duty to notify these gentlemen of their election, and I have here the letters which they wrote, accepting — as they all did — honorary membership in the Association and the honor and distinction conferred upon them by you.

I propose now, at the risk of taking a little time, to read extracts from these letters, because I take it to be a matter of marked and permanent interest to a body like this, when men of distinction, such as these whom we have elected and who have accepted

honorary membership, say some of the things which they have said in their letters.

I will read first the letter of acceptance from the eminent engineer, Mr. Joseph P. Davis. I will omit, as a rule, personal references and the address and signature:

"Your favor of the 6th inst., notifying me that I have been elected an Honorary Member by the New England Water Works Association, is at hand. I accept the election with great pleasure. Please give my sincere thanks to the Association for the honor conferred, an honor which I appreciate highly. Also please accept my thanks for the very kind terms in which you notify me of the election."

I may say that substantially the same letter was sent to all, to the effect that the Association had pleasure in conferring honorary membership upon the person addressed, in view of his distinguished services to water works science.

The next letter is from Mr. Edwin Reynolds, of Milwaukee, or rather from Mrs. Reynolds, because, I regret to say, of the illness of Mr. Reynolds. She says:

"Mr. Reynolds has been confined to his bed most of the time for the last nine months. He wishes me to say, in answer to your communication, that he highly appreciates the distinction of being an Honorary Member of your society and accepts the election with pleasure."

The next is from Mr. John T. Fanning, of Minneapolis, who says:

"I have received your letter announcing the honor conferred by the New England Water Works Association at its recent meeting in the White Mountains. I appreciate the kind words with which you have accompanied the announcement, and assure you that I appreciate such honoring remembrance of an absent member by the Association. I shall be pleased to accept the honorary membership which the Association courteously voted. I had hoped to be present at the September meeting, but was unfortunately called to an engagement in Canada just at that time."

The next is from Mr. E. D. Leavitt, of Cambridge:

"I accept with pleasure the election as an Honorary Member of the New England Water Works Association, a society whose

good work makes it *a public benefactor*. With thanks for the honor conferred, I remain,

"Sincerely yours."

The next comes from Mr. Rudolph Hering:

"I wish to convey to you my high appreciation of the honor which the Association has kindly conferred upon me, and to thank you for your kind expressions. Of course I could not do otherwise than accept the election, which brings so much honor with it, and I do so with the feeling that, while I hardly deserve what you say, my life may yet be useful in advancing the science of engineering in theory and practice, as it has always been my effort in a small way to do."

The next is from Dr. Henry P. Walcott, the distinguished chairman of the State Board of Health of Massachusetts, and a member of the Metropolitan Water and Sewerage Board of the same state:

"I have your kind note informing me of the action of the New England Water Works Association in electing me to an honorary membership in the Association. I accept the honor with great pleasure, for I have a high regard for the important work of the Association, and as a member of the State Board of Health have more than once been greatly indebted to it for advice and assistance."

From Mr. F. P. Stearns, formerly chief engineer of the State Board of Health of Massachusetts and later of the Metropolitan Water and Sewerage Board of Massachusetts:

"Your letter containing the information of my election as an Honorary Member of the New England Water Works Association was handed to me yesterday on the train as I was leaving Boston. Although I have not been able to attend many meetings of the Association in recent years, I have always highly appreciated the very good work which it has done, this result being due to the many able men enrolled in its membership and to their willingness to work and to contribute freely to the general fund of information on water works management and construction. Having such an opinion of the Association, I can and do appreciate most highly the honor conferred upon me by this election. Permit me in accepting membership in the Association to thank you, and through you the Association, for its action."

And finally from Mr. Hiram F. Mills, the eminent hydraulic engineer, who has been for so many years the devoted and self-sacrificing engineer-member of the State Board of Health of Massachusetts:

"Your very kind letter informing me of my election as an Honorary Member of the New England Water Works Association is received. It is about twenty years since at a meeting in Boston I told the members of the Association what the State Board of Health of Massachusetts proposed to do in order to improve the quality of water used in public water supplies, and asked their coöperation. In the meantime, the members within the state, almost to a man, have intelligently and cordially co-operated with the board in its efforts to render the water supplies more helpful, for which the board and their own communities have reason to thank them. The effort to improve, and the questions which the members of the Association have found it profitable to consider, have raised the standard of the men having charge of such work throughout the bounds of the Association, and I am happy to receive from such a body of men the expression of this honor."

Now, gentlemen, these well known and distinguished names stand to-day upon our roll as Honorary Members of this Association, and it seems to me they confer dignity upon and add luster to it. Let us be careful that as we go on in the future we add to our honorary membership only men of similar rank; and in adding to our active resident and non-resident and to our associate membership, let us also watch carefully over the quality and character of the men whom we invite to become members. At the same time let us not be exclusive. There are in particular a great many *young* men who ought to belong to this Association, so that they may get the benefit of contact with older men and of the papers which are read here, — the social side and the intellectual side. I think we have all been a little negligent in not bringing in more of the young men. Let us see if in the future we cannot add more of them to our active membership.

The object of this Association is, first and foremost, social intercourse. By that I mean the friction of mind on mind, the exchange of ideas, and especially of technical and professional

ideas, discovering whether we are up to date or behind the times by contact with our neighbors who may be more alert than we are in particular directions. We ought never to allow at our meetings and luncheons the formal papers to crowd out that part of our work. We ought, therefore, always to have the hour of meeting such that there shall be opportunities for social conference before or after our meetings, and generally, of course, before.

Most of us come here to get information, but we should remember that we ought to give information too. I have repeatedly urged upon the members the necessity of bringing here the results of the practical experience of every-day life, of work in the field, by noticing things that are interesting or suggestive and bringing them here and talking about them. If this Association degenerates so that our meetings become merely a place for the giving of lectures or for the reading of long disquisitions, it will never fulfill its principal function. *Discussion* is, and always will be, the essence of the successfulness of any such association as this, — the give and take, the quick answer which comes to the new idea thrown out by some one, — resisted, or accepted, or illustrated or improved upon. We need, therefore, to be careful, especially you gentlemen who are superintendents in actual service and familiar with practical details, to look out for the glib talkers — the professors and similar people — who can, perhaps, lecture to you by the hour but who, perhaps, after all, cannot help you half so much as your neighbor who may be far less fluent but far more expert in actual water works warfare. We need, therefore, to give careful attention to our *programs*. And we are not alone in this matter, for it is felt by many a society to-day that there is danger of being swamped by long papers which allow little or no time for discussion. We must have the vital discussion if we would remain successful.

In this connection a suggestion has been made by Mr. Baker that it is a pity that many of our papers are not submitted in print so that written discussions can be sent in. That is done, as you know, in many associations and societies, and it is well worth thinking of for ours. If we are becoming, almost in spite of ourselves, a body of national importance, if we have now nearly

700 members, it certainly becomes a question whether we ought not to adopt some such plan, so that the wider circle of those members who cannot come to our regular meetings may take part in our discussions. In that way it is believed that we might also get from them much that would be valuable for ourselves.

It has seemed to me, watching things as your executive officer for the last year, that on the whole the arrangements for our meetings are fairly good. If we come in punctually at one o'clock, and if our luncheon is served as rapidly as it should be, we still have time enough left for other things before the afternoon has gone and members must take trains for suburban cities or towns. But it is important that we shall be able to begin *punctually* at one, and also, of course, that the luncheon shall be quickly served.

Although often dealing with sanitary matters, we have not infrequently met under most unsanitary conditions, in rooms overheated as they used to be at Young's Hotel, and ill ventilated as has often been the case here. This matter requires very careful attention, for if one is to go home from a meeting refreshed and not tired out so that he isn't good for much the next day, it is highly important that he should have fresh air and not be overheated during the afternoon. And this raises a question which you must often have thought of, and which I have often thought of, viz., whether in this metropolis of New England we haven't now reached the time when all our engineering and scientific societies and perhaps some others, should get together and have a building of their own, a club house, if you like, with rooms for dining and with rooms for resting and sitting about and smoking and talking, — for the social side of our work, which is quite as important as the reading of papers.

I know that this question has been discussed in the past and dismissed as impracticable, but New England is getting larger all the time, associations are multiplying, wealth is increasing, and it does seem to me that the time ought to be very near, if it has not now arrived, when we should have in Boston, as they have in New York, a building adapted for work of our kind. We shall need such a building more in the future than we do to-day. While our hotels are good to us and do the best they can under

the circumstances, we ought to have rooms ventilated with the latest appliances, so that when smoke forms here it shall be carried away, as it is, for example, in the Hotel St. Regis, in New York. If you have ever dined there and seen people smoking in the dining room with ladies, — smoking anywhere, without any odor of smoke remaining in the room, — you know what good ventilation to-day is. But most people do not know, and many who do know do not seem to care. We ought to have a building used by all the scientific societies, ventilated in the latest and best way, in charge of a janitor who should be well paid and who wouldn't overheat it, but would manage things as any scientific expert who has studied the subject could tell him how to manage them. Then we could sit through one of our meetings and go out, not with a full head — yes, I hope with a full head, but not with a headache — and refreshed by good ventilation, rather than wearied by overheating and poor ventilation.

Our year has certainly been a successful one, and the editor will tell you about the JOURNAL. It seems to me that the JOURNAL is something which we want to foster with the greatest care. It is from this that our absent members get their money's worth. They get the JOURNAL, they know what has been going on, and they get the benefit of all the papers presented. The question is whether we ought not to extend the scope of the JOURNAL somewhat, whether we ought not to seek to publish still more papers of general interest relating to water and water supplies; and it seems to me that as long as we have editors such as we have thus far always had, careful and patient workers, we might afford, perhaps, to put more money into the JOURNAL, — which means into the salary of the editor and into the printing, — and extend our work somewhat in that direction, gradually perhaps, at first, but considerably later.

You remember that the American Water Works Association met here during the summer, and that our relations with the officers and members were of the most agreeable character. Your President spoke for our Association at the opening meeting in Huntington Hall, and the meeting of that Association in what we may consider our own territory was most welcome to us, and I believe most agreeable to the members of that organization. It

was at the same time very successful. There need be and should be no conflict whatever between these two bodies, — the larger national association covering the whole of these United States from the Atlantic to the Pacific and from Canada to Mexico, and the New England Association having a strong local basis here in New England but reaching out as far as experience and the demand show it wise to reach.

Two or three legislative matters of interest have come up during the year, one of them being the matter of boating on Great Ponds, in which our Association threw its influence in favor of the protection of the water supplies of the state, as I hope it may always continue to do. Another was a resolution and an effort in support of the hydrographic work of the United States Geological Survey; and the third an attempt to aid those who are seeking to provide a forest reservation in the White Mountains — something which means so much to us in connection not only with water supply but also with water power.

And that leads me to say, gentlemen, that our Association, it seems to me, runs a little too much to water supplies, municipal water supplies, and not quite enough to other aspects of water works, — to water for fire protection and especially to water powers. New England is full of water powers and there are many interesting questions coming up which we ought to hear more about from time to time than we have thus far heard at our meetings.

It would be easy for me to take up all the afternoon in talking about the past and the future of the Association, but I will spare you, simply remarking that never was there a time, perhaps — I think I may even omit the " perhaps " — never was there a time when questions of water supply and water power were more important than they are to-day, — of water supply because of the growth of city populations. The terrible epidemics of typhoid fever to-day in Scranton and in Pittsburg, Pa., lend point to my statement in that direction. The value of power in every direction to-day, the demand for power, the possibilities of profit in power, likewise make the subject of water power more important than ever before.

There is, then, ample room for our Association, ample room

for its further growth and extension, and if we all keep up our loyalty to it, if we all strive to work for it as we ought to do, there is no reason why its membership and influence should not continue to increase. I think, however, we want to beware of one thing. All of us are who busy, — and who of us is not? — naturally wish and expect the officers of the Association to take all the trouble, to run it, and to look out for its interests. That is a comprehensible point of view with any one who is busy. But the Association will never reach its highest usefulness until every member of it feels his individual duty toward it, particularly with respect to helping out as to its work and as to its programs. It is conceivable that we might have a large program-committee which should be a kind of drag-net especially devised for getting those practical experience papers upon which I have harped so long and so often, and which do not seem to be readily forthcoming. If every one of us does his duty by the Association he will get out of it even more than he puts into it, for after all that is about what we do in this world: we get out of things very much what we put into them, and if a man will put work into the Association and devotion and affection, he will be likely to reap a rich reward from it.

There came in during the year one letter which I should have read at an earlier meeting, but which now I am rather glad I did not read before. It seems we have a member in Plymouth, Mass., eighty-five years old, who has a real and abiding regard for this Association. I haven't the pleasure of his acquaintance myself, but his name is Bagnell. He writes to the Secretary in a very good hand as follows, — and if all of us at the age of eighty-five are able to write letters in his spirit we shall be testifying, as this writer does, to a deep regard for the Association:

"WILLARD KENT:

"*Dear Sir*, — I suppose my membership in the Association is closed. It is just as well. I am getting along in years. I was born in the year 1822. I am in the doctor's hands and have been for the last four months. I shall never go out of Plymouth again until I go across the silent river. I send my last year's dues so I can be square with the world, and so I can die happy.

*God bless the New England Water Works Association.* Yours until death, R. W. BAGNELL, Plymouth."

[Applause.]

In this touching and affectionate testimony from an old member it seems to me we see an example of what we may all strive ourselves to give, and an attitude which we may all strive ourselves to imitate. [Applause.]

PROFESSOR KINNICUTT. Mr. President, I think we have all listened with a great deal of pleasure to this letter from Mr. Bagnell, and I move that the Secretary be directed to transmit to him the cordial greeting of the Association, and the request that he remain a life member, all future dues being remitted. [Applause.]

THE PRESIDENT. The motion is made and seconded, and I am sure that every man of us will be glad to vote for it. I do not need to ask for any remarks, but will simply put the motion. [Adopted unanimously.]

MR. COGGESHALL. It may be proper for me to state that Mr. Bagnell was one of the 18 who organized this Association in Young's Hotel, in June, 1882.

## REPORT OF SECRETARY.

The Secretary submitted the following report:

*Mr. President and Gentlemen of the New England Water Works Association,* — I have the honor to submit the following report of membership, receipts, and disbursements of the New England Water Works Association for the year ending December 31, 1906.

### MEMBERSHIP.

| | |
|---|---|
| The total membership of the Association, January 1, 1906, was | 645 |
| The present membership is | 684 |
| A net increase during the year of | 39 |

### MEMBERS.

| | | | |
|---|---|---|---|
| January 1, 1906. | Total members | | 584 |
| | Withdrawals: | | |
| | Resigned | 8 | |
| | Died | 4 | |
| | Transferred to Honorary Membership | 3 | |
| | Dropped | 38 | 53 |
| | Carried forward | | 531 |

| | | | | |
|---|---|---|---|---|
| | Brought forward | | 531 | |
| | Initiations: | | | |
| | January | 3 | | |
| | February | 12 | | |
| | March | 6 | | |
| | June | 8 | | |
| | September | 11 | | |
| | November | 7 | | |
| | December | 17 | 64 | |
| | Two members elected in 1905, but qualified in 1906 | 2 | 66 | |
| | Reinstated: | | | |
| | Members dropped in 1905 | 9 | | |
| | Members dropped in 1906 | 12 | 21 | 618 |

HONORARY MEMBERS.

| | | | | |
|---|---|---|---|---|
| January 1, 1906. | Honorary members | 8 | | |
| | Died | 1 | 7 | |
| | Transferred from membership | — | 3 | |
| | Elected | | 5 | 15 |

ASSOCIATES.

| | | | | |
|---|---|---|---|---|
| January 1, 1906. | Total associates | | 53 | |
| | Withdrawals: | | | |
| | Resigned | 4 | | |
| | Dropped | 4 | 8 | |
| | | | 45 | |
| | Initiations: | | | |
| | January | 1 | | |
| | September | 2 | 3 | |
| | Reinstated: | | | |
| | Associates dropped in 1906 | | 3 | 51 |
| January 1, 1907. | Total membership | | | 684 |

SUMMARY OF RECEIPTS AND DISBURSEMENTS OF THE NEW ENGLAND WATER WORKS ASSOCIATION FOR THE YEAR 1906.

RECEIPTS.

| | | |
|---|---|---|
| Initiations | | $283.00 |
| Annual dues: | | |
| Members | $1 746.00 | |
| Associates | 765.00 | |
| Fractional Dues: | | |
| Members | 49.00 | |
| Associates | 10.00 | |
| Past Dues | 68.20 | |
| Total dues | | 2 638.20 |
| Carried forward | | $2 921.20 |

| | |
|---|---|
| Brought forward, | $2 921.20 |
| Advertisements | 1 756.25 |
| Subscriptions | 184.00 |
| Journals sold | 164.85 |
| Sundries | 247.88 |
| | $5 274.18 |

DISBURSEMENTS.

| | |
|---|---|
| Journal | $1 514.37 |
| Stationery | 556.57 |
| Assistant Secretary | 540.00 |
| Rent | 400.00 |
| Editor | 300.00 |
| Advertising Agent | 255.00 |
| Incidental expenses | 222.20 |
| Secretary | 200.00 |
| Reprints | 166.30 |
| Ladies' Complimentary lunch | 147.50 |
| Stenographer | 126.50 |
| Membership list | 116.00 |
| Stereopticon | 93.20 |
| Music | 80.00 |
| Printing pipe specifications | 79.75 |
| Badges | 30.00 |
| Insurance | 15.00 |
| Library | 2.75 |
| Total | $4 845.14 |
| Receipts in excess of expenditures | $429.04 |
| At the present time there is due the Association: | |
| For advertisements | $81.25 |
| For initiations and dues | 34.00 |
| For Journals | 11.00 |
| For specifications | 1.40 |
| | $127.65 |

I know of no outstanding bills against the Association.

Respectfully submitted,

WILLARD KENT, *Secretary.*

On motion of Mr. M. F. Collins, the report of the Secretary was accepted and ordered to be printed and placed on file.

## REPORT OF TREASURER.

The Treasurer submitted the following annual report:

LEWIS M. BANCROFT, TREASURER,
In account with the New England Water Works Association.

| RECEIPTS. | | | | | | EXPENDITURES. | | |
|---|---|---|---|---|---|---|---|---|
| 1906 | | | | | | | | |
| Jan. | 5 | Balance on hand | | | $2 888.73 | Paid bills, as per itemized statement | | $4 845.14 |
| Aug. | 1 | Dividend, Peoples Savings Bank | | | 53.16 | | | |
| Dec. | 1 | Dividend, Mechanics Savings Bank | | | 39.60 | BALANCE ON HAND. | | |
| Feb. | 12 | Rec'd of Willard Kent, Sec'y, | | | $959.60 | Deposit Peoples Saving Bank, Worcester | $1 559.21 | |
| April | 6 | ,, | ,, | ,, | 1 544.46 | Deposit Mechanics Savings Bank, Reading | 1 161.95 | |
| June | 6 | ,, | ,, | ,, | 402.30 | Deposit First National Bank, Reading | 157.84 | |
| July | 30 | ,, | ,, | ,, | 495.77 | Cash on hand | 531.53 | |
| Sept. | 20 | ,, | ,, | ,, | 225.87 | | | 3 410.53 |
| Oct. | 6 | ,, | ,, | ,, | 201.00 | | | |
| Dec. | 13 | ,, | ,, | ,, | 913.65 | | | |
| 1907 | | | | | | | | |
| Jan. | 5 | ,, | ,, | ,, | 531.53 | 5 274.18 | | |
| | | | | | | $8 255.67 | | $8 255.67 |

READING, MASS., January 5, 1907.

LEWIS M. BANCROFT, *Treasurer.*

DETAILED STATEMENT OF BILLS PAID.

| 1906. | | |
|---|---|---|
| January 27 | W. N. Hughes, envelopes and printing | $89.25 |
| | D. Gillies' Sons, printing | 4.75 |
| | Harry L. Thomas, expenses auditing accounts | 2.70 |
| | R. C. P. Coggeshall, expense auditing accounts | 4.40 |
| | W. W. Robertson, expense auditing accounts | 4.56 |
| | Thomas P. Taylor, stereopticon | 10.00 |
| February 13 | Miss J. M. Ham, assistant secretary, salary, January, 1906 | 45.00 |
| March 5 | Hub Engraving Company, plates | 21.12 |
| | L. M. Bancroft & Son, treasurer's bond | 15.00 |
| | William E. Whittaker, tracings | 3.50 |
| | Samuel Usher, standard specifications | 32.50 |
| | Miss Rosetta Key, singing, February 14 | 25.00 |
| | W. N. Hughes, postal cards and printing | 8.25 |
| | Miss J. M. Ham, salary for February | 45.00 |
| | Helen S. Patterson, cards | 36.00 |
| 16 | Hub Engraving Company, plate | 3.60 |
| | D. Gillies' Sons, letter heads and envelopes | 81.34 |
| | Boston Society of Civil Engineers, rent to February 28 | 100.00 |
| | Charles W. Sherman, salary to April 1 | 75.00 |
| | Charles W. Sherman, postage, etc. | 4.94 |
| April 6 | Robert J. Thomas, services, advertising agent, to April 1 | 73.75 |
| | Samuel Usher, March JOURNAL | 351.05 |
| | Willard Kent, salary to April 1, 1906 | 50.00 |
| | Willard Kent, music, guest tickets, etc. | 100.50 |
| | B. D. B. Bourne, stereopticon | 10.00 |
| | Miss J. M. Ham, salary for March | 45.00 |
| 26 | Samuel Usher, reprints | 38.00 |
| | Bacon & Burpee, reports of January and March meetings | 26.50 |
| | W. N. Hughes, printing circulars | 2.75 |
| | William E. Whittaker, tracings | 3.50 |
| | Miss J. M. Ham, salary for April | 45.00 |
| May 5 | Samuel Usher, list of members | 116.00 |
| | Hub Engraving Company, plates | 28.52 |
| 19 | D. Gillies' Sons, printing | 4.00 |
| | W. N. Hughes, printing and binding | 49.55 |
| June 7 | Miss J. M. Ham, salary for May | 45.00 |
| | Miss J. M. Ham, postage, telephone, express | 45.15 |
| | Amount carried forward | $1 646.18 |

| | | |
|---|---|---|
| | Amount brought forward | $1 646.18 |
| June 7 | Miss J. M. Ham, copying for Meter Rates Committee | 1.75 |
| | Samuel Usher, standard specifications | 47.25 |
| 8 | The Brunswick | 3.00 |
| 25 | W. N. Hughes, printing tickets | 2.25 |
| | Chas. W. Sherman, salary three months to July 1 | 75.00 |
| | Chas. W. Sherman, postage and express | 6.50 |
| | Miss J. M. Ham, salary for June | 45.00 |
| | R. J. Thomas, services advertising agent to July 1, | 62.25 |
| | Willard Kent, salary to July 1, 1906 | 50.00 |
| | Willard Kent, guest tickets, postage and express | 17.50 |
| July 23 | Samuel Usher, June JOURNAL | 312.80 |
| | W. N. Hughes, cash book | 12.00 |
| | J. M. Ham, salary for July (part) | 35.00 |
| September 7 | Samual Usher, reprints | 50.05 |
| | W. N. Hughes, envelopes and printing | 38.00 |
| | Boston Society of Civil Engineers, rent to May 31, | 100.00 |
| | D. Gillies' Sons, printing | 14.60 |
| | J. M. Ham, bal. July and August, salary | 55.00 |
| 24 | O. G. Barron, postals | 7.00 |
| | The Somerville Journal Company, printing | 1.50 |
| | Charles W. Sherman, salary to October 1 | 75.00 |
| | Charles W. Sherman, postage on JOURNAL | 5.00 |
| | Samuel Usher, reprints | 1.50 |
| | Willard Kent, salary to October 1, 1906 | 50.00 |
| | Willard Kent, cash paid account of Annual Convention | 184.00 |
| | Frank E. Merrill, expense paid acc't T. P. Taylor | 18.00 |
| October 8 | W. N. Hughes, letter heads | 5.00 |
| | Boston Regalia Company, badges | 30.00 |
| | Thomas P. Taylor, stereopticon | 35.20 |
| | J. M. Ham, salary for September | 45.00 |
| | D. Gillies' Sons, programs | 13.50 |
| 24 | Miss A. N. Hill, typewriting for Committee on Uniformity of Hydrants and Valves | 4.85 |
| | Hub Engraving Company, plates | 50.68 |
| | Wm. E. Whittaker, tracings | 8.50 |
| | Bacon & Burpee, report of September meeting | 76.25 |
| November 3 | Boston Society of Civil Engineers, rent to August 31, | 100.00 |
| | Miss J. M. Ham, salary for October | 45.00 |
| | Miss J. M. Ham, sundry expenses | 82.20 |
| 22 | Hub Engraving Company, plate | 1.18 |
| | Samuel Usher, September JOURNAL | 389.15 |
| | Amount carried forward | $3 802.64 |

| | | |
|---|---|---|
| | Amount brought forward . . . . . | $3 802.64 |
| November 22 | R. J. Thomas, services, advertising agent to November 1 . . . . . | 61.75 |
| | J. B. Fillebrown, music, November meeting . . . | 10.00 |
| | Thomas P. Taylor, stereopticon, November 14 . . | 10.00 |
| | Miss J. M. Ham, salary for November . . . . . | 45.00 |
| December 12 | Samuel Usher, reprints . . . . . | 43.00 |
| | Hub Engraving Company, plates . . . . . | 17.20 |
| | Wm. E. Whittaker, tracings . . . . . | 3.50 |
| | D. Gillies' Sons, circulars . . . . . | 12.50 |
| 29 | Hub Engraving Company, Plates . . . . . | 13.91 |
| | Boston Society of Civil Engineers, rent to December 1, 1906 . . . . . | 100.00 |
| | W. N. Hughes, printing . . . . . | 11.00 |
| | Charles W. Sherman, coypright and postage . . . | 2.00 |
| | Chas. W. Sherman, salary to December 31, 1906 . | 75.00 |
| | Thomas P. Taylor, stereopticon . . . . . | 10.00 |
| | Miss J. M. Ham, salary to December 31, 1906 . . . | 45.00 |
| | Miss J. M. Ham, express, telephone, etc. . . . . | 32.48 |
| | Bacon & Burpee, reporting November and December meetings . . . . . | 23.75 |
| | Willard Kent, salary to December 31, 1906 . . . | 50.00 |
| | Willard Kent, sundry expenses . . . . . | 34.00 |
| 1907. | Samuel Usher, printing December JOURNAL and reprints . . . . . | 344.66 |
| January 5 | D. Gillies' Sons, circulars . . . . . | 14.50 |
| | R. J. Thomas, services advertising agent to January 1, 1907 . . . . . | 57.25 |
| | La Rue Viedenburg, services . . . . . | 10.00 |
| | Prof. Geo. N. Cross, lecture on White Hills . . . . | 16.00 |
| | | $4 845.14 |

On motion of Mr. Frank L. Fuller, the report of the Treasurer was accepted and ordered to be placed on file.

## REPORT OF EDITOR.

The Editor submitted the following as his annual report:

BOSTON, January 9, 1907.

*To the New England Water Works Association,* — The following is my report for the year 1906, as editor of the JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

The accompanying tabular statements show in detail the amount of material in the JOURNAL; of receipts and expenditures on account of the JOURNAL

for the past year; and a comparison with the conditions of the six preceding years.

*Size of Volume.* — The volume is considerably smaller than that of the preceding year, as the latter had an unusual amount of material presented at the New York Convention. It is, however, larger than any other preceding volume of the JOURNAL. In comparison with this statement, it is gratifying to note that the gross cost is less than that for the three preceding years, and that the net cost, considering the size of the Association and number of pages, less than ever before since these reports have been made.

*Illustrations.* — The total cost of illustrations in the JOURNAL for the year has been $271.71, or 10.6 per cent. of the gross cost of the volume.

*Reprints.* — The usual fifty reprints of papers have been furnished to authors without charge. Some free reprints have also been furnished to members who have contributed important discussions which practically amounted to papers in themselves. The net cost to the Association of the reprints has been $91.55, or $3.98 for each of the 23 papers published during the year.

*Circulation.* — The present circulation of the JOURNAL is:

| | |
|---|---|
| Members (all grades) | 684 |
| Subscribers | 60 |
| Exchanges | 23 |
| Total | 767 |

an increase of 62 over the preceding year.

*Advertising.* — The December issue contained 26.08 pages of paid advertising, which if maintained throughout a year would mean an annual income from this source of $1 740. A year ago the figures were 28.08 and $1 985, showing a considerable decrease during the year.

*Pipe Specifications.* — During the year pipe specifications have been sold to the amount of $132.10; the expense for reprinting specifications during the year has been $79.75, leaving a net gain of $52.35 for the year. Our net income from this source a year ago was $56.70, so that the total net income at the end of 1906 has been $109.05. Of course the original cost of type-setting and illustrating these specifications was charged to the JOURNAL in which the specifications were first published, but the net receipts have now been sufficient to practically repay this expense. We still have on hand a fair supply of the specifications, enough, if sold at retail, to bring in some $40, more or less.

I know of no outstanding bills against the Association on account of the JOURNAL.

Respectfully submitted,

CHARLES W. SHERMAN, *Editor.*

## TABLE No. 1.

STATEMENT OF MATERIAL IN VOLUME XX, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1906.

| Number. | Date. | Pages of | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Papers. | Proceedings. | Total Text. | Index. | Advts. | Cover and Contents. | Inset Plates. | Total. | Cuts. |
| 1 | March | 97 | 29 | 126 | – | 31 | 4 | 8 | 169 | 9 |
| 2 | June | 98 | 12 | 110 | – | 28 | 4 | 6 | 148 | 10 |
| 3 | September | 125 | 17 | 142 | – | 28 | 4 | 12 | 186 | 6 |
| 4 | December | 108 | 9 | 117 | 7 | 28 | 4 | 3 | 159 | 16 |
| | Total | 428 | 67 | 495 | 7 | 115 | 16 | 29 | 662 | 41 |

## TABLE No. 2.

RECEIPTS AND EXPENDITURES ON ACCOUNT OF VOLUME XX, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1906.

| RECEIPTS. | | EXPENDITURES. | |
|---|---|---|---|
| From advertisements | $1 756.25 | For printing JOURNAL | $1 539.16 |
| From sale of JOURNALS | 164.85 | For preparing illustrations | 155.21 |
| From sale of reprints | 74.75 | For editor's salary | 300.00 |
| From sale of cuts | 5.80 | For editor's incidentals | 31.44 |
| From subscriptions | 184.00 | For advertising agent's commissions | 255.00 |
| | $2 185.65 | For reporting | 126.50 |
| Net cost of JOURNAL | $387.96 | For reprints and advance copies | 166.30 |
| | $2 573.61 | Gross cost of JOURNAL | $2 573.61 |

## TABLE No. 3.

COMPARISON BETWEEN VOLUMES XIV, XV, XVI, XVII, XVIII, XIX AND XX, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

| | VOL. XIV. 1899–1900. | 4 NUMBERS OF VOL. XV. 1900–1901. | VOL. XVI. 1902. | VOL. XVII. 1903. | VOL. XVIII. 1904. | VOL. XIX. 1905. | VOL. XX. 1906. |
|---|---|---|---|---|---|---|---|
| Edition (copies) | 1 100 | 1 200 | 1 200 | 1 200 | 900 | 900 | 900 |
| Average membership | 583 | 586 | 571 | 587 | 596 | 625 | 665 |
| Pages of text | 345 | 363 | 403 | 430 | 491 | 587 | 495 |
| Pages of text per 1 000 members, | 600 | 618 | 707 | 733 | 824 | 939 | 745 |
| Total pages, all kinds | 485 | 536 | 584 | 619 | 794* | 784 | 662 |
| Total pages per 1 000 members | 832 | 913 | 1 020 | 1 051 | 1 332 | 1 254 | 995 |
| GROSS COST: | | | | | | | |
| Total | $1 954.15 | $2 194.26 | $2 439.99 | $2 706.05 | $2 928.77 | $3 266.65 | $2 573.61 |
| Per page | 4.03 | 4.10 | 4.18 | 4.38 | 3.69 | 4.17 | 3.88 |
| Per member | 3.35 | 3.75 | 4.27 | 4.61 | 4.91 | 5.23 | 3.87 |
| Per member per 1 000 pages | 6.91 | 6.99 | 7.32 | 7.46 | 6.18 | 6.67 | 5.85 |
| Per member per 1 000 pp. text, | 9.71 | 10.31 | 10.60 | 10.72 | 10.00 | 8.91 | 7.81 |
| NET COST: | | | | | | | |
| Total | $347.55 | $332.90 | $622.89 | $770.62 | $648.11 | 1 072.95 | $387.96 |
| Per page | .72 | .62 | 1.07 | 1.25 | .82 | 1.37 | .58 |
| Per member | .60 | .57 | 1.09 | 1.31 | 1.09 | 1.72 | .58 |
| Per member per 1 000 pages | 1.23 | 1.06 | 1.87 | 2.12 | 1.30 | 2.20 | .88 |
| Per member per 1 000 pp. text, | 1.73 | 1.57 | 2.71 | 3.05 | 2.22 | 2.93 | 1.18 |

* Including General Index.

On motion of Mr. George A. Stacy the report was accepted and ordered placed on file.

## Report of Finance Committee.

In the absence of Mr. Harry L. Thomas, Chairman, on account of illness, the report of the Finance Committee was read by Mr. Maybury as follows:

Boston, Mass., January 5, 1907.

We, the undersigned, members of the Finance Committee of the New England Water Works Association, met this day with your Secretary and Treasurer at the headquarters of the Association, and attended to the duties devolving upon us.

We examined the Secretary's book, verified additions, and found the total receipts $5 274.18, as stated, to be correct. This amount he has turned over to the Treasurer, as his vouchers testify.

We have examined the Treasurer's accounts and found that his receipts from the Secretary agree with the amount as above stated. We have also examined the record of his payments, and find them correctly recorded, and properly certified and vouched for. These disbursements amount to $4 845.14.

We find the invested funds in two savings banks to be $2 721.16, and the cash on hand to be $689.37, all as stated in the Treasurer's report, making a total of $3 410.53 as a balance on hand for the beginning of the new year.

WILLIAM E. MAYBURY,
ARTHUR D. MARBLE,
*Finance Committee.*

On motion of Mr. R. P. C. Coggeshall the report was accepted and ordered to be printed.

## Election of Officers.

(REPORT OF TELLERS OF ELECTION.)

BOSTON, MASS., January 9, 1907.

*Mr. President,* — The tellers appointed to canvass the ballots for the election of officers of the New England Water Works Association, for the year 1907, beg leave to report as follows:

| | |
|---|---|
| Whole number of votes cast | 207 |
| Blank | 6 |
| Not properly endorsed | 11 |
| *For President.* | |
| JOHN C. WHITNEY | 196 |
| WILLIAM T. SEDGWICK | 1 |
| *For Vice-Presidents.* | |
| M. N. BAKER | 197 |
| J. M. BIRMINGHAM | 196 |
| GEORGE H. SNELL | 196 |
| V. C. HASTINGS | 196 |
| GEORGE A. KING | 196 |
| H. T. SPARKS | 196 |
| *For Secretary.* | |
| WILLARD KENT | 196 |
| *For Editor.* | |
| CHARLES W. SHERMAN | 197 |
| *For Advertising Agent.* | |
| ROBERT J. THOMAS | 197 |
| *For Additional Members of Executive Committee.* | |
| A. E. MARTIN | 196 |
| D. N. TOWER | 197 |
| GEORGE W. BATCHELDER | 197 |
| C.-E. A. WINSLOW | 1 |
| *For Finance Committee.* | |
| ARTHUR D. MARBLE | 198 |
| WILLIAM E. MAYBURY | 198 |
| GEORGE CASSELL | 197 |
| *For Treasurer.* | |
| LEWIS M. BANCROFT | 197 |

Respectfully submitted,

J. C. HAMMOND, JR.,
ERMAN M. PECK,
*Tellers.*

The President announced the election of the various officers as shown by the return of the tellers, and said he was sure all the members desired to hear a word from the incoming president, Mr. Whitney. Mr. Whitney was greeted with loud applause and responded briefly, as follows:

*Mr. President,* — I thank you sincerely for your kind introduction, and I wish to assure you and all the members of the Association that with the assistance of all the members it is hoped that we may during the coming year maintain the high standard which has been set for us by previous presidents and officers, and that in the future the Association may continue to rank, as it does now, as the foremost society of its kind in the world. [Applause.]

The following applicants having been recommended by the Executive Committee, were elected to membership:

Chester H. Wells, Montclair, N. J., health officer; F. J. Hoxie, Phenix, R. I., engaged in general hydraulic work; Charles F. Eveleth, South Lincoln, Mass., mechanical engineer; Ralph E. Tarbett, Knoxville, Tenn., bacteriologist and engineer connected with the Knoxville Water Company.

The paper for the afternoon was read by Arthur N. French, superintendent of Water Company, Hyde Park, Mass., the subject being " Meter Registration." Messrs. J. A. Tilden, George A. Stacy, Edwin C. Brooks, George H. Snell, John C. Whitney, John H. Flynn, and J. C. Hammond, Jr., participated in the discussion which followed.

Dr. Langdon Frothingham, of the Harvard Medical School, gave a brief talk on Hydrophobia.

Adjourned.

## February Meeting.

Hotel Brunswick,
Boston, February 13, 1907.

Mr. John C. Whitney, president, in the chair.

The following members and guests were present:

### Honorary Members.

W. T. Sedgwick, F. W. Shepperd. — 2.

### Members.

S. A. Agnew, C. H. Baldwin, L. M. Bancroft, W. T. Barnes, G. W. Batchelder, J. W. Blackmer, E. M. Blake, Dexter Brackett, E. C. Brooks, C. E. Childs, George Cassell, J. C. Chase, R. C. P. Coggeshall, M. F. Collins, W. R. Conard, J. H. Cook, J. W. Crawford, G. E. Crowell, John Doyle, B. R. Felton, C. R. Felton, J. N. Ferguson, F. F. Forbes, W. E. Foss, A. N. French, F. L. Fuller, A. S. Glover, F. E. Hall, J. O. Hall, E. A. W. Hammatt, G. W. Hawkes, H. G. Holden, J. L. Howard, H. R. Johnson, W. S. Johnson, E. W. Kent, Willard Kent, G. A. King, L. P. Kinnicutt, C. F. Knowlton, E. S. Larned, F. A. McInnes, Hugh McLean, H. V. Macksey, N. A. McMillen, D. E. Makepeace, F. E. Merrill, H. A. Miller, William Naylor, O. E. Parks, E. M. Peck, T. A. Peirce, J. H. Perkins, H. E. Royce, G. A. Sanborn, E. M. Shedd, C. W. Sherman, H. W. Sanderson, W. F. Sullivan, L. A. Taylor, R. J. Thomas, H. L. Thomas, W. H. Thomas, L. D. Thorpe, D. N. Tower, J. A. Tilden, W. H. Vaughn, R. S. Weston, J. C. Whitney, O. J. Whitney, G. E. Wilde, F. I. Winslow, G. E. Winslow. — 73.

### Associates.

Builders Iron Foundry, by F. N. Connet; Coffin Valve Company, by H. L. Weston; The Fairbanks Company, by F. A. Leavitt; Hersey Manufacturing Company, by Albert S. Glover, J. A. Tilden, and W. A. Hersey; National Water Main Cleaning Company, by G. F. Whitney and A. P. Foster; International Steam Pump Company, by Samuel Harrison; Lead Lined Iron Pipe Company, by Thomas E. Dwyer; H. Mueller Manufacturing Company, by George A. Caldwell; National Meter Company, by C. H. Baldwin and J. G. Lufkin; Neptune Meter Company, by H. H. Kinsey; Platt Iron Works Company, by F. H. Hayes; Rensselaer Manufacturing Company, by C. L. Brown; A. P. Smith Manufacturing Company, by F. N. Whitcomb; Union Water Meter Company, by F. L. Northrop; United States Cast Iron Pipe and Foundry Company, by Frank W. Nevins; R. D. Wood & Co., by Walter Wood and William F. Woodburn. — 21.

GUESTS.

Hon. Sidney B. Kane, Somerville, Mass.; Arthur C. King, Taunton, Mass.; W. E. Rawson, Uxbridge, Mass.; E. A. Blackmer, Plymouth, Mass.; John C. DeMello, Jr., general foreman, New Bedford, Mass.; M. F. Wright, Butler, Pa.; F. L. Clapp, Stoughton, Mass.; E. P. Byrne, city engineer, Medford, Mass.; H. E. Cowan, J. E. Taylor, William Lyman Underwood and A. G. Norton, Boston, Mass. — 12.

[Names counted twice — 4.]

The Secretary presented applications for membership, properly endorsed and recommended by the Executive Committee, from the following:

Charles Saville, Waban, Mass., assistant in the engineering department of the Massachusetts State Board of Health; Charles H. Rollins, Watertown, Mass., member of the Board of Water Commissioners, Watertown; George C. Bunker, Charleston, S. C., biologist and chemist, city of Charleston; Halsey French, New York, assistant engineer, Board of Water Supply, New York City; M. G. Hall, Centerville, Ia., superintendent of water works, Centerville.

On motion of Mr. Fuller the Secretary was instructed to cast one ballot in favor of the applicants named, and they were declared duly elected members of the Association.

The President presented a letter from an absent member, asking for experience with "Universal" cast-iron pipe. Messrs. John H. Cook, Charles W. Sherman, and Wm. R. Conard spoke upon this subject.

At this point the President called upon Mr. William R. Conard, of Burlington, N. J., who presented a paper entitled "Some Observations on Cast-Iron Pipe Specifications." The paper was discussed by Frank A. McInnes, Wm. E. Foss, John Doyle, Frank L. Fuller, and Walter Wood.

William Lyman Underwood, Esq., lecturer in the biological department of the Massachusetts Institute of Technology, gave a talk on the work of river drivers in the Maine woods, illustrated by stereopticon views.

Adjourned.

## EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Wednesday, December 12, 1906, at 11.30 A.M.

Present: President Sedgwick and members, Charles W. Sherman, John C. Chase, Robert J. Thomas, Lewis M. Bancroft, Frank E. Merrill, and Willard Kent.

The following applications, twenty-three in number, were received and recommended for membership: John W. Maxcy, consulting engineer, Houston, Tex.; Arthur B. Cleaveland, United States Reclamation Service, Orman, S. D.; Albert L. Sawyer, water registrar, Haverhill, Mass.; E. F. Kitson, civil engineer, Norfolk, Va.; Nathaniel W. Hayden, president and manager, Windsor Water Company, Windsor, Conn.; Charles F. Breitzke, White Plains, N. Y.; Perkins Boynton, chemist, East Jersey Water Company, Little Falls, N. J.; William H. Beers, Jr., bacteriologist, Water Department, Columbia, N. C.; William L. Butcher, State House, Boston, Mass.; W. F. Currier, chemist, Philadelphia, Pa.; Herbert C. Emerson, M.D., Springfield, Mass.; Frederick W. Farrell, bacteriologist, Emerson Laboratory, Springfield, Mass.; Selskar M. Gunn, assistant bacteriologist, Iowa State Board of Health, Iowa City, Iowa; August E. Hansen, sanitary engineer, New York City; John H. McManus, assistant engineer, Board of Water Supply, City of New York, West Hurley, N. Y.; James A. Newlands, chemist, Connecticut State Board of Health, Middletown, Conn.; Burton G. Philbrick, water sanitarian with Lederle Laboratory, Brooklyn, N. Y.; Henry A. Pressey, Washington, D. C.; William J. Roberts, professor of civil engineering, State Agricultural College, Pullman, Wash.; Louis J. Richards, health officer, Board of Health, Elizabeth, N. J.; Luther R. Sawin, bacteriologist, New York Water Department, Mt. Kisco, N. Y.; L. R. Thurlow, health officer, Plainfield, N. J.; Alex. J. Taylor, engineer, Sewer Department, Wilmington, Del.

Voted: That three members and two associates dropped for non-payment of dues, who have since forwarded amount of dues, be reinstated to former membership.

Voted: That the following resolution be presented to the Association.

[Resolution printed on page 76.]

The place of the next Annual Convention was considered and the subject referred to a later meeting.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

---

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., January 9, 1907, at 11.30 A.M.

Present: President William T. Sedgwick, and members John C. Chase, James L. Tighe, Robert J. Thomas, Lewis M. Bancroft, Frank E. Merrill, Charles W. Sherman, George A. Stacy, and Willard Kent.

Four applications were received and recommended for membership, viz., Charles F. Eveleth, South Lincoln, Mass.; F. J. Hoxie, Phenix, R. I.; Chester H. Wells, Montclair, N. J.; Ralph E. Tarbett, Knoxville, Tenn.

Voted: That the subject of place of next annual convention be referred to the incoming Executive Committee with the recommendation that it be held within the limits of New England.

Voted: That the Secretary, Treasurer, Editor, and Advertising Agent be a Committee on Ladies' Day with full power to add to their number, and to act for the Executive Committee.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

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Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., January 24, 1907.

Present: President John C. Whitney, George A. King, D. N. Tower, George W. Batchelder, Robert J. Thomas, and Willard Kent.

The records of the last meeting of the Executive Committee were read and approved by vote.

On motion of Mr. Thomas, seconded by Mr. King, it was voted:

That the annual custom of inviting the attendance of ladies at the February meeting be dispensed with for that occasion of the present year.

Voted: That the President and Secretary be a committee to arrange program of papers for the February meeting.

Voted: That the President and Secretary be a committee to provide music for the February meeting.

The June meeting, annual convention, and subject of a general circular relating to membership were discussed and referred to a later meeting.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

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Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., February 13, 1907, at 11.30 A.M.

Present: President J. C. Whitney, and members Robert J. Thomas, L. M. Bancroft, D. N. Tower, George W. Batchelder, George A. King, Charles W. Sherman, and Willard Kent.

The records of the last meeting were read and approved.

Applications for membership were received from the following-named persons:

Charles Saville, engineering department, Massachusetts State Board of Health, Boston, Mass.; Charles H. Rollins, water commissioner, Watertown, Mass.; Halsey French, assistant engineer, Board of Water Supply, city of New York, N. Y.; George C. Bunker, biologist and chemist, city of Charleston, Charleston, S. C.; M. G. Hall, superintendent water works, Centerville, Ia.

These applications were considered, and it was voted to recommend them to the Association for election to membership. One other application was received and action thereon postponed.

On motion of Mr. Thomas, seconded by Mr. Bancroft, it was voted that the President and Secretary be, and hereby are, authorized to make the necessary arrangements for the June meeting of the Association.

A request from prominent members of the Association was received asking that the Treasurer of the Association be paid a

nominal salary of fifty dollars per annum; whereupon it was voted that the salary of the Treasurer for the year 1907 be fifty dollars.

On motion of Mr. Thomas, seconded by Mr. Batchelder, the salary of the Assistant Secretary for the year 1907 was increased to fifty dollars per month.

On motion of Mr. Batchelder, seconded by Mr. Thomas, the Secretary was authorized and instructed to investigate and report on the subject of a desirable place for holding the next annual convention.

Adjourned.

Attest: WILLARD KENT, *Secretary.*